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GEOLOGY AND MINERAL RESOURCES of the NEW FLORENCE QUADRANGLE

PENNSYLVANIA

By
M. N. Shaffner

DEPARTMENT OF INTERNAL AFFAIRS
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GEOLOGY AND MINERAL RESOURCES NEW FLORENCE QUADRANGLE

A 57

By M. N. Shaffner

INTRODUCTION

Location and Area

The New Florence quadrangle is located in southwestern Pennsylvania (Figure 1). It includes an area of approximately 227.2 square miles, extending from latitude N. 40°15′ to 40°30′ and from longitude W. 79°00′ to 79°15′. The quadrangle occupies 87.9 square miles of southeastern Indiana County, 122.8 square miles of northeastern Westmoreland County, 7.6 square miles of southwestern Cambria County, and 8.9 square miles of northwestern Somerset County. The length from north to south is about 17.3 miles, and its width, from east to west at the south is 13.1 miles, and at the north is .05 of a mile shorter owing to the northward convergence of the meridians.

IMPORTANCE OF MINERAL RESOURCES

The New Florence quadrangle is in an important coal-producing region, and coal mining has been an important factor in its economy. The coal resources in this area have been exploited commercially since late in the nineteenth century, but the reserves far exceed that which has been removed.

The quadrangle has been explored for natural gas at various places and although encouraging shows have been encountered. small commercial production is limited to "shallow sand" pools in the Lower Mississippian and Upper Devonian strata in the northern part of the area. Four deep test wells, all unsuccessful, have also been drilled in the quadrangle. In addition to fuels, the Loyalhanna limestone has furnished large tonnages of material for road metal and aggregate. There are also extensive deposits of plastic clay, some impure flint clay, shale, sandstone, relatively thin beds of limestone suitable for agricultural use, and minor iron ores.

Because of the importance of the mineral resources in this area and because it was surrounded by quadrangles already mapped, mapping was begun as soon as possible after the end of World War II.

FIELD WORK

Field mapping and collection of data for the preparation of this report was begun by the author in the summer of 1947, and continued in parts of the summers through 1951. Field mapping consisted of a systematic and thorough examination of the area. Elevations on outcrops, mines, etc., were determined by aneroid barometer. Important stratigraphic sections were measured by planetable and alidade.

Aerial photographs were invaluable aids in plotting the areal geology. The aerial-photographs are on a scale of approximately 1:20,000 or one mile equals 3.1 inches. Each photograph covers approximately 7.8 square miles and they overlap in stereoscopic pairs. Aerial photographs viewed stereoscopically show formational contacts having differential resistance

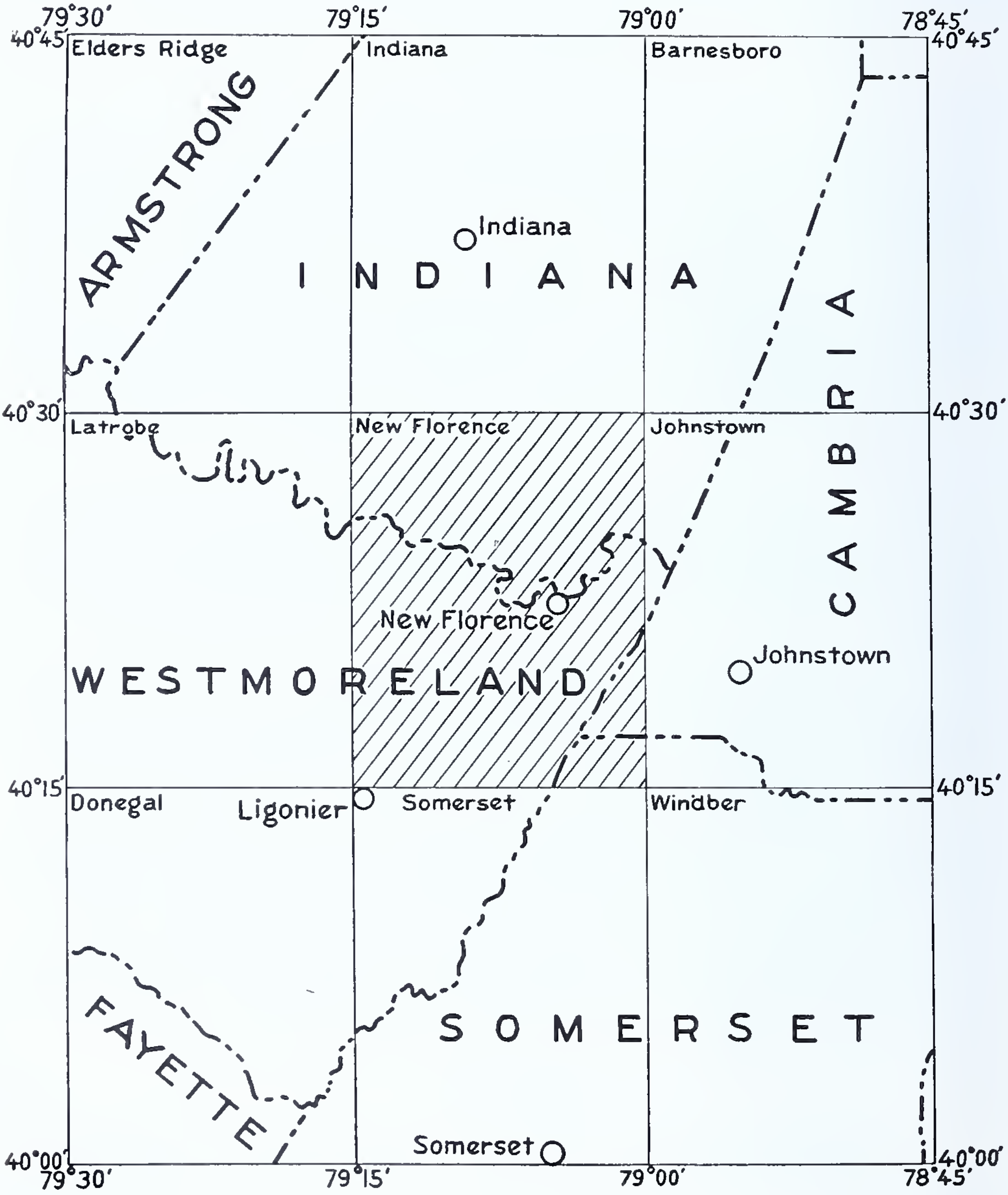


FIGURE 1. Map showing location of New Florence quadrangle.

to erosion expressed topographically as benches or as conspicuous changes in the slope of the terrain. Formational contacts plotted on the photographs were transferred instrumentally to the topographic map. As would be expected, inaccuracies in the details of the topographic map were detected, particularly in the forested mountain areas; hence, at some places it was necessary to make arbitrary adjustments in plotting formational boundaries.

The less resistant rocks underlying the lowlands are deeply weathered to a thick mantle of soil, and natural outcrops are rare. The dominating massive resistant sandstones which form the mountains break out along fracture planes into boulders of various dimensions forming talus on the spurs and in the ravines. Exposures of underlying strata under these conditions are infrequent. Stratigraphic sections are observable only where they are exposed in cuts along railroads and highways.

PREVIOUS GEOLOGIC WORK

H. D. Rogers (1858, vol. 1, p. 479), State Geologist of Pennsylvania, in his final report, briefly described the geology of the area embraced by the New Florence quadrangle. The Second Geological Survey of Pennsylvania established in 1874, published reports which cover most of the State. Reports by W. G. Platt (1877) and J. J. Stevenson (1878) describe the geology of the quadrangle in some detail. Although the field work preparatory for these reports was essentially the reconnaissance type, the general geologic interpretations are accurate.

ACKNOWLEDGMENTS

The author is grateful to those who furnished the information essential to the successful completion of this report. It is unfortunately impractical to mention by name all of the individuals and organizations. Information was made available by the Bethlehem Steel Company, The Garfield Refractories Company of Bolivar, The Imperial Coal Corporation of Johnstown, The Rochester and Pittsburgh Coal Company of Indiana, the Pennsylvania Electric Company and Vinton Collieries Company of Vintondale.

SETTLEMENTS AND INDUSTRIES

The original Indians in the region were Delawares and Shawnees. The early settlers were of Scotch, German, and Irish descent. They were hunters and trappers who subsisted largely on the wildlife, and by trading furs and skins at the forts and blockhouses. Fort Ligonier was built by the British in 1758 during the French and Indian Wars, and served as a fortified camp; resting and provisioning General Forbes' Army in his campaign to recapture the Fort at the "Forks of the Ohio". Fort Ligonier also served a vital purpose in our history as the "Key to the West", and was a refuge for settlers. Several severe attacks by the French and Indians in 1758 were repulsed; the fort was never taken by the enemy.

With the development of the coal industry in the latter part of the 19th Century, came emigrants from foreign countries, particularly Austrian, Italian, Polish, and Slavic people.

Although coal mining and minor beehive coke manufacture contribute substantially to the economy, the area is dominantly agricultural. Clay products, and electric power developed from coal as fuel are also produced. The iron industry flourished briefly in the early part of the 19th Century.

Ligonier, whose northern boundary extends into the southwest corner of the New Florence quadrangle has a population of 2,160 (1950) and is the trade center of the Ligonier Valley. New Florence, for which the quadrangle is named, is on the south side of the Conemaugh River on the main line of the Pennsylvania Railroad in the east-central part of the quadrangle; it has a population of 924. Seward and Boltz, small mining communities, lie to the northeast along the Conemaugh River. Bolivar and Robinson are former mining communities along the Conemaugh River in the central part. Scottglen, Claghorn, Heshbon, Josephine and Blacklick are former mining towns along Blacklick Creek in the northern part of the quadrangle as are Fort Palmer, Wilpen and Old Colony in the Ligonier Valley at the southwest.

TRANSPORTATION

The quadrangle is everywhere accessible by concrete and macadam highways. The area is well served with rail transportation. The main line of the Pennsylvania Railroad follows the Conemaugh River through the gorges of Laurel Hill and Chestnut Ridge. The Lang Hollow extension of the Pennsylvania Railroad from Johnstown follows the north side of the river. The Blacklick Branch of the Pennsylvania Railroad from Ebensburg runs along the north side of Blacklick Creek, and the Indiana Branch runs northward from Blairsville to Indiana. Ligonier Valley Railroad was built in 1877 and was privately owned. It plied between Latrobe and Ligonier, serving the mines working the Pittsburgh coal in the Ligonier Valley. These mines were worked out about 1938, and the railroad was abandoned in 1952.

The region is also served by buses running on regular schedules.

CLIMATE AND VEGETATION

The climate of the region is of the temperate, humid continental type, similar to that of the greater part of western Pennsylvania. The change in temperature from one season to another is gradual, and the range in temperature between the coldest and warmest months is considerable. The summer months are generally mild, but brief periods of oppressively hot weather occur. Winters are not continually cold; only occasional sub-zero temperatures occur. Areas of higher elevations average slightly colder temperatures.

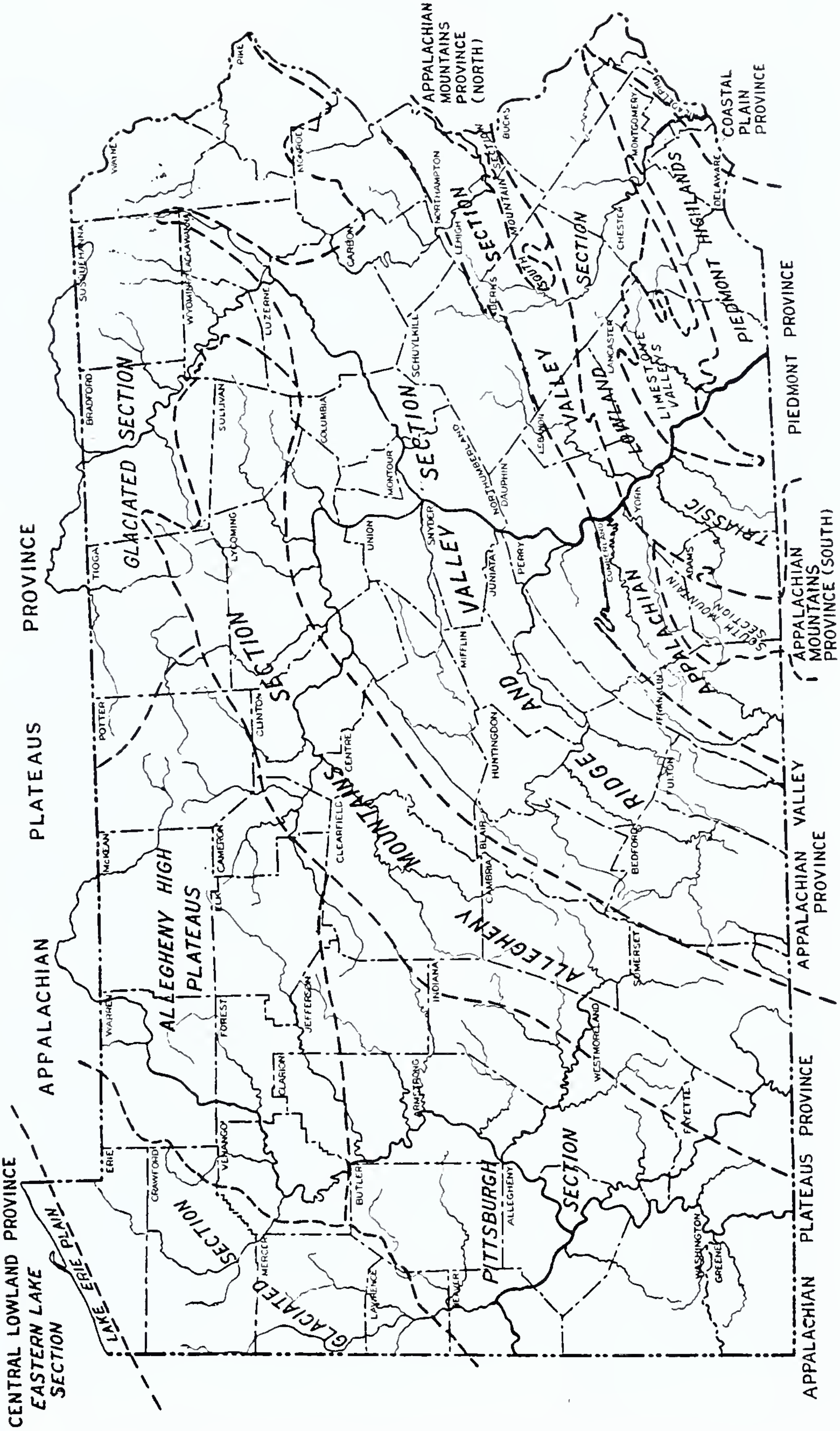


FIGURE 2. Physiographic subdivisions of Pennsylvania.

Seasons also vary from one year to another. Wet years, in which precipitation in some form is heavy, are followed by spring floods. Drought years, when precipitation is subnormal, result in some wells running dry.

The mean annual temperature is about 46°F., and the mean annual rainfall is about 40 inches. The average length of the growing season is about 113 days. For details on temperature and precipitation see U. S. Weather Bureau "Climatological Data."

The original stand of timber consisted mainly of various kinds of oak, chestnut, black walnut, sugar maple, poplar, locust, beech, and birch; with conifers occurring mostly in the moist, shady ravines on the uplands. One or more stands of timber have been cut, and each succeeding stand becomes poorer. The timber lands today are mainly on the rocky slopes and crests of the mountains; small, scattered wood lots are in the valleys. Repeated forest fires have destroyed large areas of timber land, resulting in worthless scrubby growth.

PHYSIOGRAPHY

GENERAL RELATIONS

According to Fenneman (1938) the topography of Pennsylvania falls within six physiographic provinces (Figure 2). They are from east to west as follows: The Coastal Plain Province, the Piedmont Province, the Greater Appalachian Valley Province, the Appalachian Mountain Province, the Appalachian Plateau Province, and the Central Lowland Province. These provinces are subdivided into sections.

Western Pennsylvania is included in the Appalachian Plateau Province, which trends generally southwest in a broad belt, extending from the Adirondack Mountains in New York to northern Alabama. It terminates at the east in a prominent escarpment called the Allegheny Front; and gradually merges into the Central Lowlands Province at the west.

The Appalachian Plateau Province in Pennsylvania is subdivided into five sections as follows: the Lake Erie Plain, the Glaciated Section in the northwest and northeast, the Allegheny High Plateau in the north, the Allegheny Mountains Section in the east and the Pittsburgh Section in the southwest. The New Florence quadrangle lies mostly within the Allegheny Mountains section of the Appalachian Plateau Province. The topography is characterized by strong relief, consisting mainly of two prominent mountain ridges, and an intervening, broad, undulating valley. These features are as follows: Laurel Hill, Ligonier Valley, and Chestnut Ridge. These topographic features are the result of folding and differential erosion.

The mountain ridges are parallel and trend generally north 30° east. The linear crests are a series of high points and saddles; the limbs are marked by deep ravines and intervening spurs, which lend a rugged character to the topography.

Laurel Hill, the dominant topographic feature of the area, is about five miles wide and extends for 8.5 miles across the southeastern part of the quadrangle. The high point at the southern boundary of the quadrangle is contoured at 2,860 feet.

Ligonier Valley which extends from southwest to northeast across the quadrangle is the northern extension of the Ohiopyle Valley in Fayette County. Ligonier Valley is particularly striking in the area south of the Conemaugh River where it is flanked by high-standing Laurel Hill and Chestnut Ridge; and from foothill to foothill is about six miles wide. The topography of the valley is mature and is characterized by minutely dissected, irregular hills with an average relief of about 400 feet. Because of the gradual northeast plunge of the Chestnut Ridge anticline, which is referred to below, the Ligonier Valley becomes less conspicuous north of the Conemaugh River.

Chestnut Ridge crosses the western part of the New Florence quadrangle, and forms the western escarpment of the Allegheny Mountains section. The ridge is separated into two parts by a gorge formed by the Conemaugh River. The limbs have a fairly uniform rise from the adjacent valleys, but the slope of the east limb south of the river is interrupted by a strike fault which is expressed by a hogback of resistant Pottsville sandstone.

From a high point contoured at 2620 feet near the southwestern boundary of the quadrangle, the anticlinal mountain plunges northeastward at a fairly regular rate. Therefore, the mountain-making rocks become progressively lower in elevation, and north of the Conemaugh the relief is so reduced that Chestnut Ridge is nearly obscured.

The small area of lowland in the northwestern part of the quadrangle west of Chestnut Ridge lies in the Latrobe basin, and is included in the Pittsburgh section of the Allegheny Plateau Province.

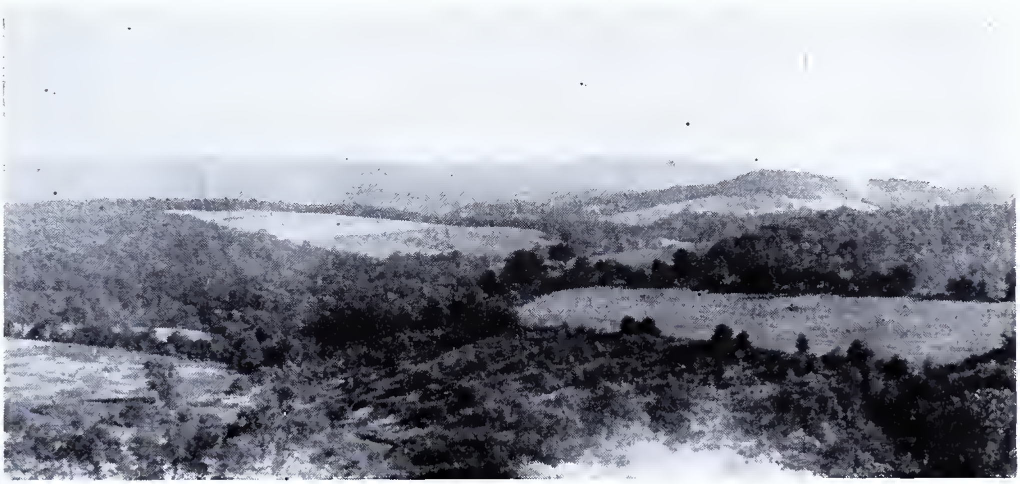


FIGURE 3. Looking east from Pa. Route 711 across Ligonier Valley, Laurel Hill in distance.

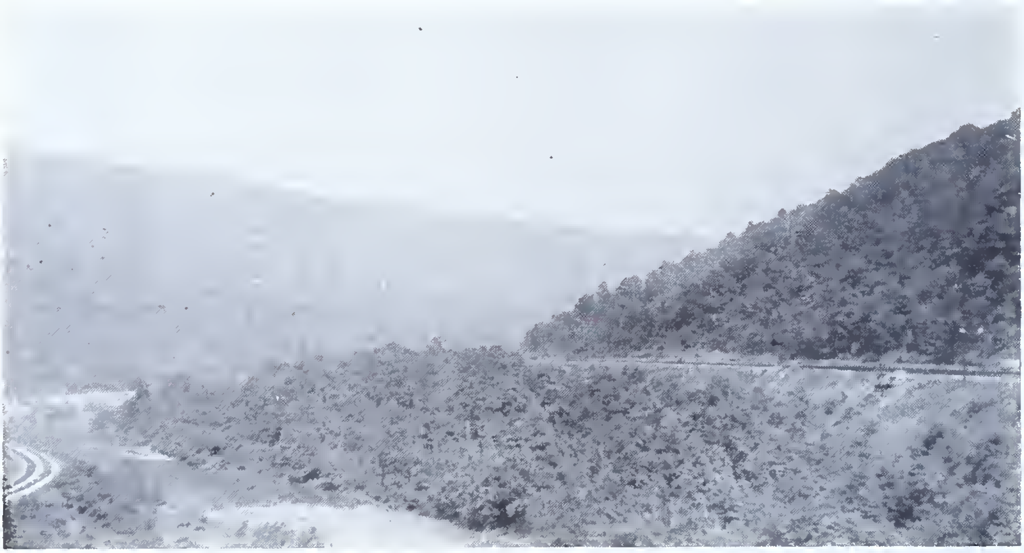


FIGURE 4. Conemaugh gorge through Chestnut Ridge, looking east.

EROSIONAL SURFACES

Earlier workers (Campbell 1904, Phalen 1911) in the areas adjacent to New Florence quadrangle have recognized and made tentative correlations of erosional surfaces or peneplains. Because of the abstract nature and scope of these problems, conclusions are largely indefinite and disagreement inevitable. Most of the observers, however, have concluded that the crests of Laurel Hill and Chestnut Ridge are remnants of an early peneplain and correlate it with the Schooley peneplain of eastern Pennsylvania and New Jersey. Campbell (1904) thinks that the erosional surface about 1,000 feet below the Schooley corresponds to the Harrisburg peneplain, also in eastern Pennsylvania; and the surface 100 feet lower correlates with the Worthington peneplain of western Pennsylvania. A still lower surface at an elevation from 1000 to 1040 feet, he considers to be late Tertiary, and correlates it with Parker strath in western Pennsylvania.

There is general concordance of hilltops at various levels in the New Florence quadrangle, and remnants of a general terrace up to about 100 feet above the present flood plain of the larger streams is also noted. The author has made no attempt to correlate these partial erosional surfaces with those described elsewhere. It may be safe to conclude that these surfaces are at least indicative of local base leveling. Narten (1948) has studied the erosional surfaces in the New Florence quadrangle, but he feels that his work is too incomplete to draw any concrete conclusions.

RELATION OF THE GEOLOGY TO THE TOPOGRAPHY

The most conspicuous relationship between the geology and the topography in the New Florence quadrangle is expressed by the synclinal Ligonier Valley and the flanking-linear, anticlinal ridges of Laurel Hill and Chestnut Ridge. The original land surface in earlier geologic time stood higher than the crests of the present ridges. As the surface was being reduced, erosion was considerably retarded when the underlying harder rocks were encountered in the anticlines, but was continued at a normal rate in the softer rocks in the synclines. This differential erosion resulted in the high relief between the valley and mountains today (see Plate 1).

The slope and configuration of the hills in the lowlands is also controlled by the underlying rocks. Where the hills are underlain by shale, they tend to be evenly rounded; and where the surface is underlain by sandstone, the hills are a little higher and nearly flat-topped. A series of alternating shale and sandstone ledges gives a hillside a terraced effect, as does a succession of coal beds with underclays and associated shales.

The relatively wide flood plain and meandering course of the Conemaugh River in Ligonier Valley was developed because of the resistance to downcutting of the stream through the harder rocks in the gorge of Chestnut Ridge, thus affording opportunity for the stream to widen and aggrade the resultant flood plain where the river traverses the softer rocks. The structure and differential hardness of the rocks in the valley also appear to have been factors in influencing the meandering course of the stream. On the geology and mineral resources map (Plate 1), it will be noted that the bends of the stream roughly simulate the structure contours. This is particularly apparent where the axis of the Ligonier syncline crosses the river at New Florence. It may therefore be concluded that in the process of deepening its channel, the stream was deflected by inclined, resistant strata.

DRAINAGE

The New Florence quadrangle is in the Ohio-Mississippian drainage system. The quadrangle is drained almost entirely by the Conemaugh River and Blacklick Creek. These streams have deeply entrenched channels, and persist in their courses with apparent disregard for obstacles. West of Bolivar this phenomenon is particularly striking where the Conemaugh River has cut a steep-sided, picturesque gorge about 1000 feet deep directly across the hard rocks forming Chestnut Ridge.

The Conemaugh River, the largest stream in the quadrangle, has its source near the Allegheny Front to the east. It enters the quadrangle just north of the center of the eastern boundary and pursues a winding course generally westward, leaving the quadrangle at the northwest boundary, and from there flows northwestward into the Allegheny River in southwestern Armstrong County. The northern divide of the Conemaugh River is marked by Pa. Route 22. The named south-flowing tributaries are: Richards Run, Roaring Run and Toms Run. The north-flowing tributaries are: Baldwin Creek, Tubmill Creek, and Snyders Run.

Blacklick Creek has its source in Cambria County to the east. It follows an irregular course from east to west across the northern part of the New Florence quadrangle and joins the Conemaugh River at Blairsville in Latrobe quadrangle. The named tributaries in the quadrangle are: Marldis Run, Ramsey Run, Brush Creek, Aulds Run, Palmer Run, Two Lick Creek, and Weirs Run.

A small area in the southwestern part of the New Florence quadrangle is drained by Mill Creek which is a tributary of Loyalhanna Creek, which in turn flows into the Conemaugh River at Saltsburg in southwestern Indiana County. Named tributaries of Mill Creek in the quadrangle are: Hannas Run, Coalpit Run, and North Fork.

The main stream on the east slope of Laurel Hill in the quadrangle is Benns Creek.

Most of the streams in the New Florence quadrangle are polluted by mine drainage and are devoid of aquatic life; but they have had an important bearing on the economy of the area. Their valleys expose the edges of valuable mineral deposits, and the larger streams have afforded a means of transportation thereby making those resources accessible.

GEOLOGIC HISTORY

Fundamental Processes

The topography or character of the present surface of this region was determined by the entire geologic history of the area from early Cambrian time (550 million years ago) to the present. The Appalachian geosyncline, a long, narrow trough that extended across eastern North America from the Gulf of Mexico to the Gulf of St. Lawrence, was covered intermittently by vast inland seas in which the rocks underlying this region were deposited as a series of sediments. These sediments were derived to some degree from the continental interior and largely from land areas, which bordered the trough on the southeast. The sea floor was slowly depressed as it was filled with sediments, and the lands to the east were repeatedly uplifted and eroded. By the end of the Paleozoic, more than 30,000 feet of sediments had accumulated in the trough east of the Allegheny Mountains, but these deposits became thinner to the west. The deposits such as mud, sand, limy material, clay and coal, varied with changing conditions. Accumulation was not continuous, but was interrupted by recurrent uplifts which often raised the ocean bottom above sea level. Some of the newly laid sediments were thus eroded, and later sediments, deposited in the area when it had again subsided, were laid unevenly upon the eroded surfaces.

Toward the end of this long period of deposition, conditions became more stabilized near sea level and vast swamps, in which thick layers of plant remains accumulated, covered the area. Subsequent intermittent periods of deposition allowed the accumulation of more sediments upon this vegetable matter. These layers were compressed and consolidated by the weight of the overlying material.

Near the end of Permian time, mountain-making forces from the southeast compressed essentially flat-lying beds of sediments and formed the ancestral Appalachian mountains. In eastern Pennsylvania the crushing and folding was intense, but only mild folding took place in this area and elsewhere in western Pennsylvania.

Contemporaneous with, and subsequent to the folding, weathering and stream action were active and reduced the land to an almost featureless surface, or peneplain. It was on this plain that the present master drainage channels of the area were established, such as the Conemaugh River and Blacklick Creek. Their meandering courses suggest that they were developed on a nearly level surface.

Subsequent regional uplift was gradual and without folding or faulting of the rocks. The rejuvenated streams renewed the process of downcutting but maintained their original courses. Downcutting of the streams was apparently equal to uplift thus enabling the Conemaugh River to maintain its course across Chestnut Ridge.

STRATIGRAPHY

GENERAL DISCUSSION

Both the exposed and the unexposed or subsurface rocks penetrated in drilling for natural gas in the New Florence quadrangle are included in the Paleozoic (ancient life) era, which is one of the major geologic time divisions. Rocks of Paleozoic age are subdivided into seven systems in descending order as follows: Permian, Pennsylvanian, Mississippian, Devonian, Silurian, Ordovician, and Cambrian. Excepting for about 280 feet of upper Devonian strata all of the exposed rocks in the New Florence quadrangle are included in the Pennsylvanian and Mississippian systems.

A total thickness of about 2,800 feet of rocks is exposed in the quadrangle, and about 5,800 feet of subsurface rocks have been penetrated in drill holes. These rocks, all sedimentary in origin, consist of sandstone, conglomerate, shale, siltstone, coal, clay, limestone, and some thin beds of impure iron ore; shale and sandstone predominate. Igneous rocks were not noted in this area.

All of the rocks are stratified or layered and, for the most part, are a series of repeated sediments. With the exception of small amounts of unconsolidated silt, sand and gravel in the recent flood plains (Quaternary) of the larger streams, and coal which accumulated under swamp conditions, these rocks are either continental deposits or marine shallow sea deposits. A few limestones, for example, are definitely marine in origin and contain marine fossils. The thickness and nature of the individual members change from place to place. For instance, a sandstone is thick and massive at one place, and within a relatively short distance its corresponding place in the section is occupied by other material, and a locally thick coal bed may thin out or terminate abruptly. The discontinuity of a locally prominent member is accounted for either by non-deposition or by deposition and subsequent erosion. Regionally, however, the formations maintain similar characteristics. For example, the Conemaugh is dominantly shaly with thin coals, the Allegheny contains valuable coals and clays and the Pottsville is composed mostly of massive sandstone.

QUATERNARY DEPOSITS

The unconsolidated, Quaternary deposits in the New Florence quadrangle are mostly recent in age. They occur on the small disconnected flood plains and in the streams. These deposits consist of clay, sand and gravel, which have not been transported far from their source and are commonly poorly assorted. Only small local deposits of clean sand were noted. Small scattered pockets of gravel occur up to about 100 feet above the flood plains of the larger streams and probably are Tertiary in age. The area has not been glaciated.

PENNSYLVANIAN SYSTEM

General Discussion

The Pennsylvanian system is an important part of the geologic column of North America. It was appropriately named for this State, because it was here that these strata were first studied and the sequence worked out (Rogers 1858).

The Pennsylvanian was the time of greatest bituminous coal making in the earth's history. Extensive forest-covered marshes and plains were generally prevalent and, where moisture was abundant and constant, organic matter was preserved to become a coal bed. There was also deposition of continental and marine sediments such as sand, mud, and calcareous material, in greatest multiplicity of lateral and vertical variations, and with remarkable regional persistence of some beds.

The vertical succession of rocks of the Pennsylvanian system is characterized by cyclic or repeated sequences of sediments. The cycles are the result of a regularly repeated sequence of conditions of sedimentation. Udden (1912) subdivided the Pennsylvanian strata in the Peoria quadrangle, Illinois, into "four successive stages: (1) accumulation of vegetation; (2) deposition of calcareous material; (3) sand importation; and (4) aggradation to sea level and soil making".

Wanless and Weller (1932) proposed the name cyclothem to the rocks composing a repeated series of sediments. Pettijohn (1948) defined a cyclothem as follows: "It is a group of strata of formational or member status that is arranged in a definite sequence or order."

The boundaries of a cyclothem have been drawn at various places by various geologists. Weller (1930) draws the boundary at the base of the sandstone because sandstones commonly lie unconformably upon subjacent beds in the Pennsylvanian strata. Unconformities are common at the base of sandstones in the New Florence quadrangle, and sandstone would therefore be a logical boundary or cyclothems in this area.

Rocks of the Pennsylvanian system in the area embraced by this report are dominantly continental in origin, and consist of conglomerates, coarse to fine sandstones, sandy to argillaceous shales, siltstones, coal beds, clays, limestones, and secondary iron oxides and carbonates. Definite marine deposits are relatively few, and are represented by thin limestones and calcareous shales containing marine invertebrates.

Graphic sections of the Pennsylvanian system in the New Florence quadrangle, constructed almost entirely from the records of diamond core drill holes are shown on Plates 2-5. The apparent modification in corresponding parts of the section indicates that depositional conditions during any cycle of the Pennsylvanian were not regionally uniform. Coal

PLATE 4 STRATIGRAPHIC SECTIONS

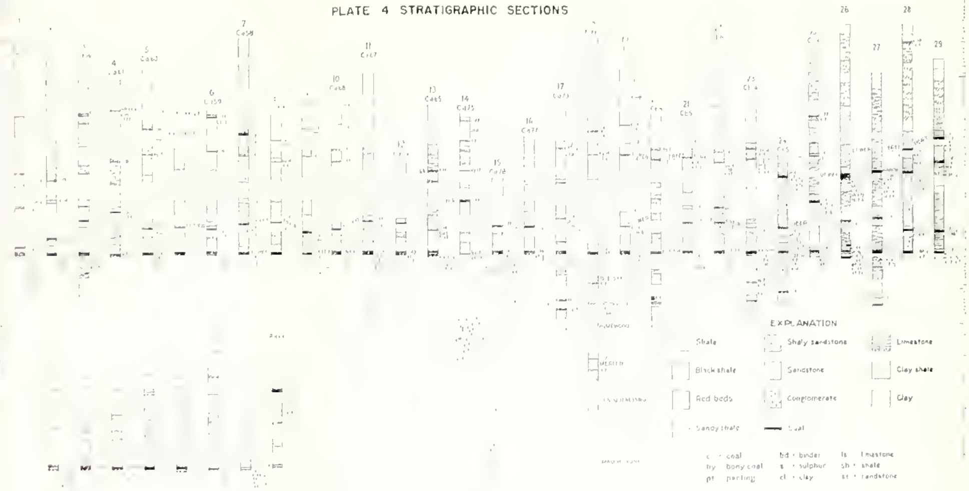


PLATE 3. STRATIGRAPHIC SECTIONS

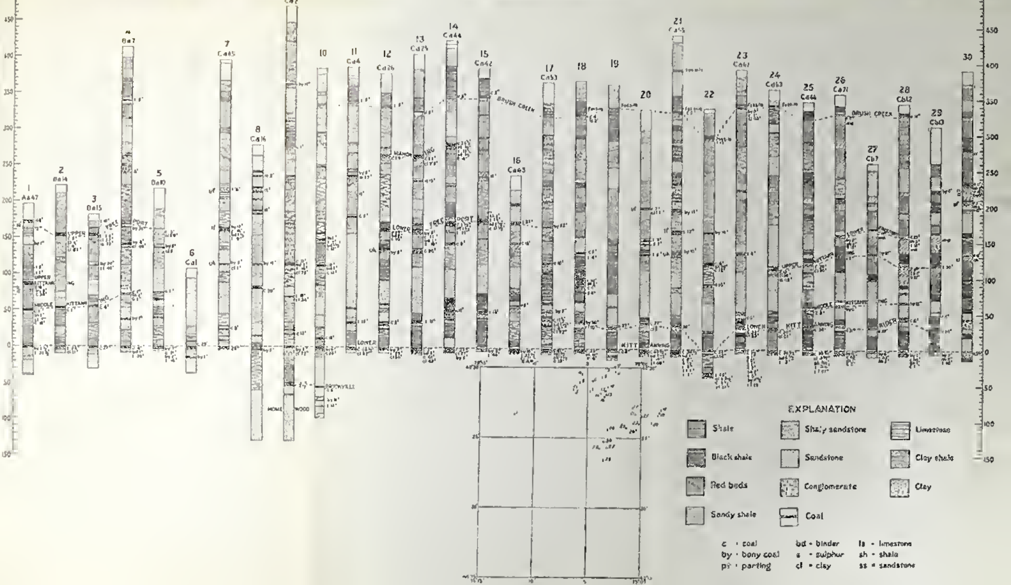
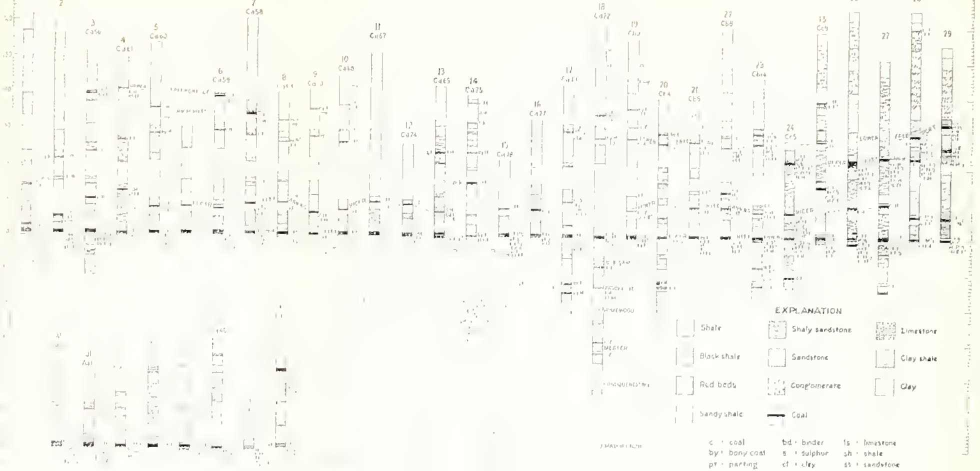


PLATE 4. STRATIGRAPHIC SECTIONS



beds thin out or are abruptly replaced by other material, usually sandstone; limestones grade latterally into clay or shale. Field observation revealed local disconformities particularily at the base of sandstones which commonly show evidence of erosion, such as sand-filled channels cut into evenly bedded subjacent strata indicating interruption of sedimentation and removal of previously deposited beds.

The graphic sections also show that most of the cyclothems are incomplete with one or more units missing and do not fulfill the requirement for the ideal cyclothem consisting of a sequence of sandstone, shale, limestone, clay, and coal.

The Pennsylvanian system is subdivided into four major divisions, each having gross distinction but whose boundaries have been placed at generally recognizable and minable coal beds. These subdivisions in descending order are as follows: Monongahela series, Conemaugh series, Allegheny series, and Pottsville series.

Monongahela Series

General discussion. The Monongahela series takes its name from the Monongahela River in southwestern Pennsylvania, along which these strata are well exposed. The series was formerly called the Upper Productive Coal Measures. The strata consist of limestone, shale and sandstone with several beds of minable coal.

In the New Florence quadrangle, remnants of the Monongahela series cap the higher hilltops in the northwestern part in the Latrobe syncline; and in the southwestern part in the Ligonier syncline the maximum uneroded thickness of about 220 feet occurs west of Fort Palmer. The complete thickness in the Latrobe quadrangle to the west is 440 feet. The limits of the series extend from the top of the Waynesburg coal down to the base of the Pittsburgh coal. The lower part of the Monongahela series as exposed in the Ligonier syncline contains the following prominent members in descending order: (Plate 2, section 14) Fishpot limestone, Redstone coal, Redstone limestone, Pittsburgh Rider coal and limestone, and Pittsburgh coal.

Fishpot limestone. The Fishpot limestone was named by J. J. Stevenson (1876) for Fishpot Run in Washington County. It is called the Sewickley limestone in West Virginia because of its association with a coal of that name. The Fishpot limestone in the New Florence quadrangle is preserved only in two hilltops in the deeper part of the Ligonier syncline, and is about 220 feet above the top of the Pittsburgh coal, and 50 feet above the top of the Redstone coal. The limestone was quarried in a small way in the hilltop west of Fort Palmer (Ac 12)*, but it is now concealed. The limestone is exposed in a small quarry on a hilltop north of Old Colony (Ac 20) where it is at least five feet thick, and occurs in beds up to 12 inches thick separated by relatively thinner clay shales. The color is dark bluish gray, weathering to light gray or buff; it is hard, compact, and has a subconchoidal fracture.

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* Reference point in coordinate system on geology and mineral resources map Plate 1—see explanation page.

Redstone coal. The Redstone coal was named by Rogers (1858) from exposures along Redstone Creek in Fayette County. The coal is preserved as erosional remnants in the New Florence quadrangle on the higher hilltops in the Ligonier syncline from west of Fort Palmer to near Old Colony, where it underlies a total of approximately 145 acres. This coal bed is about 160 feet above the base of the Pittsburgh coal and has an average thickness of 60 inches. A typical section is as follows: shale or sandstone roof, bony coal 11 to 12 inches, clay or clay shale 8 to 12 inches, coal 34 inches, shale parting one inch, coal 26 inches, plastic clay. A film of iridescent iron oxide is locally present on the face and butt cleats, and it is therefore also called "peacock" coal. Numerous knife-edge shale partings and pyrite in irregular lenses and balls are present in the bed; it reportedly has a 16 percent ash content. The interval of 50 feet from the Fishpot limestone is filled with shale, sandy shale, and thin beds of sandstone. The Redstone coal was mined and stripped for local consumption at a few places (Ac 13, 14, 16, 18) and it is practically worked out.

Redstone limestone. This limestone is so-called for its relationship with the Redstone coal from which it is separated by an average interval of 35 feet, usually filled with gray and dark shales. The limestone has an observed maximum thickness of 8 feet, and is bluish-gray, hard, dense, with a subconchoidal fracture; the weathered surface is light-gray or buff. Because of a fairly regular joint system and calcareous shale partings, the rock weathers out into boulders of approximately uniform size with fracture surfaces commonly rounded by solution. Farmers have worked this limestone at various places in the Ligonier syncline. Fair exposures were found in small quarries southwest of Fort Palmer (Ac 15) and west of Wilpen (Ac 17). This limestone is also present in the Latrobe syncline and was quarried on a small scale south of McCrea Row (Aa 3) and northwest of Smith (Aa 38).

Pittsburgh rider coal and limestone. The Pittsburgh Rider coal and associated limestone are so-called because of the proximity of the exceedingly valuable Pittsburgh coal bed. The rider coal is unimportant in this area. The coal is exposed in the high walls of some of the strip mines in the Pittsburgh coal where the rider coal is either thin or the horizon is marked only by carbonaceous shale. The maximum observed thickness of 18 inches is in the highwall of a strip mine south of Shawley School (Ac 27).

The limestone is separated from the coal by a few feet of clay and shale. This stone has physical characteristics similar to the limestones described above. Apparently it is persistent in the area from just north of Fort Palmer to Myers School where it was worked at various places by farmers for their own use (Ac 11, 19, 22) and is normally 8 to 10 feet thick. The average interval between the respective bases of this limestone and the Redstone above is 70 feet and is normally composed of gray and dark shales alternating with relatively thinner sandstone beds, but at some places, the lower part of the section contains a greenish-gray, fine-grained micaceous sandstone up to 10 feet thick. This is the Upper Pittsburgh sandstone of Fayette County.

Pittsburgh coal. Because the Pittsburgh coal is discussed in some detail in this report in the section on coal resources, the following description is only general. The bed was preserved in the New Florence quadrangle in relatively small, detached erosional remnants in the Ligonier syncline to the southwest and in the Latrobe syncline to the northwest. Large-scale commercial mining was begun on the coal in this area early in the century and continued to about 1938 when economically recoverable coal was practically exhausted. A few custom mines were working the remaining stumps and pillars in 1951 but the Pittsburgh coal today remains a memory of historic interest. Many of the remarkable characteristics of the Pittsburgh coal elsewhere in the bituminous fields of southwestern Pennsylvania are prevalent in the bed in this area. With minor local exceptions, it maintained a uniform thickness that ranges from 5 to 8 feet; a variable thickness of bony coal is at the top and one or two persistent partings are present in the lower part of the coal section. The section from the top of the Pittsburgh coal to the base of the Rider limestone ranges from 35 to 55 feet thick and is normally composed of black and gray shale to about the middle where the beds become increasingly sandy. The upper Pittsburgh sandstone appears not to be a conspicuous member in the area. Where noted, it is fine-grained, greenish-gray micaceous, thin-cross-bedded. Minor channeling is evidenced locally in the highwalls of strip mines, where gray, slabby, coarse-grained sandstone containing lenses of carbonized plant remains lies unconformably on the roof shale of the Pittsburgh coal and at some places cuts into the coal bed.

The base of the Monongahela series is placed at the base of the Pittsburgh coal.

Conemaugh Series

Distribution and thickness. The Conemaugh series was originally called the Lower Barren Coal Measures, and was renamed by Franklin Platt (1875), from outcrops along the Conemaugh River in Cambria County. The series is limited by the base of the Pittsburgh coal and the top of the Upper Freeport Coal.

Rocks of the Conemaugh series are widely distributed in the New Florence quadrangle. They underlie the Ligonier Valley, extending as a broad band between the foothills of Laurel Hill and Chestnut Ridge and are interrupted only at the northeast where Blacklick Creek has cut its channel into rocks of the underlying Allegheny series. Conemaugh rocks occupy the Latrobe syncline at the northwest and are preserved on the higher knobs on the north-plunging axis of the Chestnut Ridge anticline in the vicinity of Blacklick Creek. A small area in the southeast corner of the quadrangle, on the east slope of Laurel Hill, is also covered with lower members of the Conemaugh series. As compiled from partial sections measured on the surface and from records of core drill holes, these rocks have a total thickness of about 750 feet in the New Florence quadrangle. The reported thickness of the series in the adjacent quadrangles is as follows: Johnstown, at the east, 850 to 960 feet (Phalen 1911); Somerset, at the southeast, 850 feet (Richardson 1934); and the Latrobe at the west, 650 to 700 feet (Campbell 1904). These measurements indicate a progressive regional thinning of the Conemaugh series from east to west.

Lithology. The rocks comprising the Conemaugh series (see Plates 2, 3) are alternating sequences of shale, siltstone, sandstone, impure clay, limestone, thin coal beds and minor iron ores. Shales dominate the section and vary in color from buff through shades of gray to black. Certain parts of the section commonly contain brick-red and purplish-red shales which are clayey or sandy and usually are associated with limestone horizons. At the outcrop the sandy beds retain their shaly structure, whereas the clayey beds weather into a soft structureless mass of plastic clay. These red beds contain small disseminated impure iron ore. The coloration of fine sediments in the coal-bearing rocks is not too well understood.

The sandstones are generally irregular in thickness and distribution. Sandstone characteristically is present in certain parts of the section, but sandstone may locally occupy the place of other materials in all parts of the section. The material grades from thin, weak, fine-grained beds to hard, coarse-grained massive beds with local pebbly lenses; cross bedding is generally conspicuous. The thinner-bedded sandstones are usually fine-grained greenish-gray with fairly abundant mica. The massive sandstones have gradational shades of gray and locally may be composed of fairly pure quartz grains having varying degrees of size and roundness; graywackish sandstones also occur. Some exposures of sandstone display excellent examples of channel filling. The channel sandstones commonly are coarse-grained and contain carbonized plant remains. Coal, clay, and limestone is repeated at approximately regular intervals in the Conemaugh series. As explained earlier, these depositional cycles or cyclothems are frequently incomplete or entirely missing. The coal beds are commonly thin, and where thick enough to mine, numerous partings in the bed render the coal practically worthless. The exposed plastic clays are generally impure. Relatively thick beds of clay are indicated in some core drill records (Plates 2, 3) but the quality is uncertain. Minor semi-flint clays were also noted. The limestones are mostly impure fresh water deposits, and usually occur in proximity to red beds. Some of the limestones locally are intraformational conglomerates. They are composed of very dense medium dark gray limestone fragments in a matrix of brownish gray silty limestone. Megascopically, the conglomeratic texture is scarcely noticeable on the fresh surface. The weathered surface, however, exhibits a naturally etched surface through differential weathering of the matrix and the limestone fragments. Two limestones, the Ames and Brush Creek, containing a marine fauna, are also present in the area. The iron ores consist of oxides and carbonates. The oxides apparently are restricted to the zone of oxidation, particularly as partial replacement of calcareous deposits. Carbonate ore is common as scattered concretions in the shales above coal horizons, but is not abundant enough to be of commercial value.

Correlation. Rocks of the Conemaugh series are generally covered by a mantle of soil, and natural exposures are rare. Surface sections were therefore obtained by putting together measurements of partial exposures. A better insight as to the nature of this thick succession of sediments is had from the numerous graphic sections of plotted diamond core drill records shown on Plates 2, 3. These sections reveal the change in facies from place to place, and the repeated depositional sequences. The variable nature and similar lithologies of these repeated sediments presents a difficult problem in tracing and correlating time equivalents from place to place, hence correlations are uncertain. The fossiliferous marine Ames and Brush Creek limestones have distinctive characteristics and are invaluable key horizons, but only a few exposures were found. Excepting these and a few other recognizable beds, most of the other members of the Conemaugh series in the New Florence quadrangle have not been traced progressively into this area with certainty. Correlation in the ensuing descriptions is based on a tentative comparison with the lithology and approximate corresponding stratigraphic position of those beds that have been studied and described in other areas. The identity of some units occurring in this area is uncertain.

The nomenclature in the literature concerning the Conemaugh is confused by many local pseudonyms and inconsistencies. The designations applied in this report are those commonly used in the descriptions of the members of the Conemaugh series.

The named members of the Conemaugh series in the New Florence quadrangle are as follows:

Upper Pittsburgh limestone
Lower Pittsburgh coal and limestone
Connellsville sandstone
Clarksburg limestone and red beds

Morgantown sandstone
Wellersburg coal and limestone
Birmingham and Washington red beds
Ames limestone and Harlem coal
Pittsburgh red beds and Ewing limestone

Saltsburg sandstones
Upper Bakerstown coal and Woods Run limestone
Cambridge red beds
Lower Bakerstown coal and Cambridge limestone
Meyersdale red beds
Buffalo sandstone

Brush Creek limestone and coal
Mahoning members

Upper Pittsburgh limestone. As indicated largely by partial exposures, this limestone is a persistent member of the upper Conemaugh series in the Ligonier syncline about Fort School and Old Colony and it lies about 45 feet below the base of the Pittsburgh coal. The best exposure was found in a small pit north of Reed School (Ac 9) where the bed is four feet thick, bluish-gray on a fresh surface and buff to light gray on a weathered surface, and is hard, dense, with a subconcoidal fracture. The limestone is covered by a few feet of weathered clay shale containing scattered limonite nodules, then 12 inches of carbonaceous shale which in turn is overlain by shale and sandstone beds. The Upper Pittsburgh limestone is partially exposed in a cut on Pa. Route 711 near Fort School (Bc 12).

Lower Pittsburgh coal and limestone. These beds lie about 75 feet below the base of the Pittsburgh coal and are separated from the Upper Pittsburgh limestone by shale, and sandstone beds. The coal is thin and worthless. The limestone apparently is continuous in the area mentioned above and is similar to the limestone member above it. A small pit southwest of Old Colony (Ac 23) revealed the following section:

Section southwest of Old Colony

	Ft.	*In.*
Shale, dark	1	
Coal	0	2½
Shale, black	0	4
Coal	0	4
Shale, gray	0	5
Limestone	3	exposed

The Upper and lower Pittsburgh limestones were not seen in the Latrobe syncline.

Connellsville sandstone. The Connellsville sandstone was named by Franklin Platt (1876) for that place in Fayette County where it is a conspicuous feature of the geology and lies just below the Lower Pittsburgh limestone.

The sandstone identified as Connellsville sandstone in the New Florence quadrangle is a hard, resistant rock where it is preserved in the Ligonier syncline. The base lies at about 110 feet below the base of the Pittsburgh coal and the deposit is from 15 to 20 feet thick. The sandstone is slabby, medium-grained, greenish-gray and sparingly micaceous in the upper part, becoming thicker-bedded, to massive and coarser-grained in the lower part. The resistant character of this rock is displayed north of Fort Palmer Church (Bc 13), north of Fort School (Bc 9), and west of Fort School (Bc 11) where it was worked in a small quarry for road metal. The outcrop is marked by durable weathered-out boulders in the vicinity of Shawley School. Another small quarry on the Connellsville sandstone is located east of Wilpen (Ac 24). The Connellsville sandstone is also present in the Latrobe syncline. The character of the rock generally is similar to the occurrence in the Ligonier syncline; it is about 20 feet thick and fairly well exposed north of Campbells Mill (Aa 23).

Clarksburg limestone and red beds. The name Clarksburg was applied by I. C. White (1891) to a limestone in the upper part of the Conemaugh series lying above the Morgantown sandstone in West Virginia. This limestone is also described by Hickok and Moyer (1940) in Fayette County where it is embedded in red shales. These deposits are represented in the New Florence quadrangle. They appear in the Latrobe syncline occupying an interval from about 115 to 170 feet below the Pittsburgh Coal. A partially exposed section north of Campbells Mill (Aa 23) shows relatively thin limestone beds in red and green shales. An upper one of the limestone beds was quarried and burned for local use east of Campbells Mill (Aa 19). The bed is at least 2 feet thick; the rock is bluish-gray, hard and dense.

Clarksburg limestone beds are present in the Ligonier syncline, but the outcrops show only weathered nodules. Part of the interval containing them is exposed in a road cut north of Fort Palmer (Ac 4) where the following section was measured:

Section north of Fort Palmer

	Ft.		*In.*
Shale, olive drab	4	+	
Limestone, bluish gray, dense, hard	0		8
Shale, olive drab and dark	1		7
Limestone, bluish gray, dense, hard	1		0
Shale, greenish, limy	5		0
Limestone, bluish gray, dense, hard	2		6
Clay shale, greenish, limy	1	+	

Weathered limy nodules imbedded in shale mark the horizon of the Clarksburg limestone where about 50 feet of the section above the Morgantown sandstone is exposed on Pa. Route 711 north of Oak Grove (Ac 26).

Morgantown sandstone. The Morgantown sandstone was named by J. J. Stevenson (1876) for exposures of a sandstone in the upper part of the Conemaugh series near Morgantown, West Virginia. This member is reported to be widely distributed in southwestern Pennsylvania, and its continuity has been traced into the New Florence quadrangle where it is a strong resistant rock along its line of outcrop. This sandstone is particularly well developed in the Ligonier syncline where it is as thick as 40 feet and the top lies about 210 feet below the base of the Pittsburgh coal. The sandstone grades downward from thin and slabby beds in the upper part, which are usually fine-grained, greenish gray and gray wackish to increasingly thicker gray, coarser-grained beds in the lower part. Mica flakes are fairly abundant in the upper part and carbonized plant impressions occur locally in the lower part; thin shale partings are common throughout.

The upper part of the Morgantown sandstone is exposed in a cut on Pa. Route 711 northeast of Oak Grove (Ac 26). Stone for construction of Hillview iron furnace, which was built in 1850 and is still standing, was quarried from the Morgantown sandstone nearby (Ac 25). This sandstone underlies the nearly flat hilltops about West Fairfield, and the lower part is exposed in a cut on Pa. Route 711 at the village, where the base lies on an unevenly eroded clay surface (Bb 36).

Incomplete exposures of the Morgantown sandstone appear in the Latrobe syncline north of Campbells Mill (Aa 2) and in a cut on Pa. Route 119 east of Smith (Aa 35).

Wellersburg coal and limestone. A thin coal underlain by limestone, usually associated with red beds, lies immediately below the Morgantown sandstone in the Ligonier and Latrobe synclines and occurs at the approximately corresponding position of the Wellersburg members described by C. K. Swartz (1922) in the Castleman and Georges Creek basins in Maryland. A coal bed with an underlying limestone, locally called Elk Lick, are reportedly 30 inches and 36 inches thick, respectively, where they had been worked on the hillside northwest of Luther School (Bc 22).

Limestones, with the position of the coal marked by carbonaceous shale, are exposed in a small quarry north of Fort Palmer (Bc 10) where the following section was measured:

Section north of Fort Palmer

	Ft.		*In.*
Sandstone (Morgantown) gray fine-grained	6	+	
Shale, olive and carbonaceous	5	—	0
Limestone, bluish gray, conglomeratic	3	—	0
Shale, gray, fissile	2	—	0
Limestone, greenish, argillaceous	3	—	0
Shale, olive, ferruginous	9	—	0
Limestone, dark bluish gray	2	—	0
Shale, dark, limy			

An exposure of the Wellersburg members was found in a ravine north of Fort School (Bc 8) where the coal is 12 inches thick and the underlying limestone is 36 inches thick. The following section in the cut on Pa. Route 711 at West Fairfield (Bb 36) shows the Wellersburg limestone and associated beds. The unconformable contact at the base of the Morgantown sandstone indicates that if the coal had been deposited, it was eroded by local planation. The identity of the coal bed lying 21 feet below the limestone is uncertain.

Section at West Fairfield

	Ft.	*In.*
Sandstone, Morgantown		
Unconformity		
Clay, impure	3	6
Limestone, dark bluish gray	1	8
Clay and shale, light gray and greenish gray, contains limonite nodules	21	0
Coal	0	10

The upper part of the Wellersburg section is exposed in an outcrop west of Campbells Mill in the Latrobe syncline (Aa 21). Following is the section.

Section west of Campbells Mill

	Ft.		*In.*
Sandstone, gray, medium-grained, flaggy, Morgantown			
Shale, gray	8	—	0
Shale, carbonaceous, Wellersburg coal horizon	0	—	6
Clay, alternating green and red	9	—	0
Limestone, nodular	3	—	0
Shale, green	6	+	0

Core drill holes in the Latrobe syncline (Plate 2, sections 1-5) between Campbells Mill and Strangford show discontinuity of the Wellersburg coal and limestone.

Birmingham and Washington red beds. An interval of about 125 feet from the base of the Wellersburg limestone to the top of the Ames limestone is dominantly composed of shale containing lenses of limestone and thin coals, and a variable thickness of red beds occur at irregular positions in the section. The red beds are within the general range of the Birmingham and Washington red beds named by Stevenson (1906). These red beds commonly crop out in the Ligonier and Latrobe synclines as partial weathered exposures of incoherent masses of brick and purplish-red clays with occasional nodules of limestone. A fair exposure of red beds and limestone is revealed in a cut on U. S. Route 119 east of Smith (Aa 33) and the following is the section:

Section east of Smith

	Ft.		*In.*
Shale and shaly sandstone			
Clay, sandy, greenish gray, containing limestone nodules	10	—	0
Limestone nodules	1	—	8
Shale, purplish-red	15	—	0

Something of the erratic nature of these deposits in the middle part of the Conemaugh is revealed in the graphic sections of core drill holes between Campbells Mill and Strangford (Plate 2, sections 1-5).

Ames limestone and Harlem coal. The Ames limestone was named by Andrews (1873) for its occurrence in eastern Ohio and replaces the name "Crinoidal limestone" of earlier reports. This marine limestone has remarkable distribution in southwestern Pennsylvania, northern West Virginia and eastern Ohio; it thickens generally from east to west.

The horizon of the Ames limestone has an extensive outcrop in the New Florence quadrangle, particularly in the Ligonier syncline south of the Conemaugh River, but exposures are exceedingly rare; in fact only two fair exposures of the limestone were found. The horizon was located mostly by the associated red beds wherein the weathered limestone was marked by residual limonite nodules in clay, and by the underlying carbonaceous shale indicating the position of the Harlem coal. This sequence is the clue to a marine deposit, because, like other areas, the marine Ames and Brush Creek limestones lie immediately above carbonaceous deposits, whereas fresh water limestones occur under carbonaceous deposits.

The Ames limestone occupies an approximately medial position in the Conemaugh series in this area, being about 400 feet below the Pittsburgh coal and about 350 feet above the Upper Freeport coal. Nodules of the limestone containing fossils were noted southwest of Shawley School (Ac 6) and on U. S. Route 22 north of Strangford (Aa 39). At these localities the bed is indicated by weathered nodules of limestone 6 to 8 inches in largest dimension. The fresh surface shows that it maintains the characteristics typical of it in other regions; being greenish-gray and abundantly fossiliferous. As can be seen in the graphic sections of core drill holes (Plate 2, sections 1-5) the Ames limestone is replaced by other beds locally. The details of the Ames limestone and associated beds in section 3, as logged by the driller are as follows:

Section in core drill hole

	Ft.		In.
Shale, red	24	—	0
Slate, black	5	—	10
Limestone, Ames	0	—	9
Slate, black	1	—	9
Sandstone	0	—	4
Slate, black	0	—	1
Coal, Harlem	0	—	4½
Fire Clay	0	—	5
Slate, black	0	—	9
Fire Clay	4	—	4

Identification of the fossils in the Ames limestone was not attempted by the author. Raymond (1908-1910) described the fauna in the Ames limestone from some localities in southwestern Pennsylvania. He reports the limestone in a small quarry one-quarter mile west of Blairsville Intersection (not found by the author) and noted the following species: *Chonetes granulifer* c, *Ambocoelia planaconvexa* c, *Derbya crassa* c. He also states "that fossils are very abundant and further search would doubtless bring to light many more species."

The Harlem coal takes its name from a town by that name in Carroll County, Ohio (Andrews 1873) where it is a workable bed. It is reported to be a fairly pure coal 2 to 3 feet thick at some places in Fayette County (Hickok & Moyer, 1940). This coal appears to be unimportant in the New Florence quadrangle. Good exposures were not found, but the outcrops show a poor "bloom" indicative of thin coal. A coal bed was opened northwest of Shawley School (Ac 3) at the approximate position of the Harlem and reportedly is 4 feet thick, but it is believed that this thickness is exaggerated. Core drill holes that have penetrated the horizon of the Harlem coal show either a few inches of bony coal or other deposits occupying its position (Plate 2, sections 1-5). The detailed section above shows its relation to the Ames limestone.

Pittsburgh red beds and Ewing limestone. Red beds are common in about the middle part of the Conemaugh series in practically all of southwestern Pennsylvania. They are prominent in the area about Pittsburgh and were, therefore, called the Pittsburgh Red beds.

They were seen at various places, particularly in the Ligonier syncline, but crop out in poor exposures and are usually in a weathered condition. The sections on Plate 2 which include the interval from about 100-120 feet below the horizon of the Harlem coal show red beds dominating the interval locally and being only minor constituents or wanting in other sections.

Calcareous or carbonaceous deposits also are locally present at about 50 feet below the Harlem coal and may be related to the Ewing limestone horizon in Fayette County. (Hickok & Moyer, 1940.) The horizon is indicated by nodules of limestone or black shale at a few localities.

Saltsburg sandstones. Stevenson (1878) gave the name Saltsburg to a sandstone conspicuously exposed along the Conemaugh River and Loyalhanna Creek at Saltsburg in Indiana County. In a restricted sense, the usage of the name Saltsburg is applied to a sandstone above the Upper Bakerstown coal horizon. In the New Florence quadrangle, the interval from about 200 to 300 feet above the Upper Freeport coal contains what apparently is a series of overlapping, lenticular sandstone units and the name Saltsburg is here loosely applied to sandstones included in that interval, or upward from the Lower Bakerstown coal horizon.

Fine exposures of these sandstones occur in the Ligonier syncline along Hendricks Creek from Liberty Hall to Factory School. A small abandoned quarry north of Liberty Hall (Bb 35) reveals 35 feet of light, medium-grained, fairly pure quartz sandstone, in beds that are massive at the bottom and grade to thinner, slabby ones toward the top; the stone was quarried for rough masonry. Sandstone was obtained for road metal in a quarry about one-quarter mile farther north (Bb 33). Here, thin, fine-grained, greenish-gray beds at the top give way to gray, massive coarse-grained beds at the bottom containing scattered, small, milky quartz pebbles and thin lenses and chips of greenish shale; the estimated thickness is 40 feet. On a hillside a little farther north (Bb 32) there are 25-foot detached blocks of medium-coarse-grained massive sandstone showing foreset beds at the top, and thin, irregular, closely spaced ribbons of limonite in a 5-foot section at the middle. Resistant Saltsburg sandstones are topographically expressed in the upland about Lockport, south of Bolivar about Clyde, south of New Florence and west of Ross Mountain Park. Partial outcrops were observed at various localities in the southwestern part of the Ligonier syncline. The erratic nature of the Saltsburg sandstones is disclosed in the sections shown on Plate 2.

Upper Bakerstown coal and Woods Run limestone. The Upper Bakerstown coal and the Woods Run limestone (Raymond 1908-1910) are important members in the lower part of the Conemaugh series in some areas in southwestern Pennsylvania. A thin coal and limestone of spotty occurrence lying about 250 feet above the Upper Freeport coal in the New Florence quadrangle is considered the correlative of those members.

The coal was seen at only a few widely scattered places. It is exposed in the railroad cut northwest of Josephine (Aa 7) where it has attained its observed maximum thickness of 40 inches in this area, but the coal is impure and worthless. This extreme thickness is apparently local since the bed is reduced to a thickness of 6 inches about 200 feet southwestward in the cut. An exposed outcrop of the Upper Bakerstown coal on U. S. Route 22 west of Armagh (Ca 57) measures 17 inches thick. A country bank opened on the coal north of Robindale (Cb 2) showed the coal to be 33 inches thick and underlain by shaly limestone. Reports of early explorations of the coal in this locality claim a maximum thickness of 48 inches. The Upper Bakerstown has a reported thickness of 18 inches where it was opened in a drift east of Fort School (Bc 7) and it is 15 inches thick at an outcrop east of Fort Palmer Church (Bc 14).

Only one exposed outcrop of the Woods Run limestone was found in the area and that is along U. S. Route 22 northeast of Strangford

(Aa 41) where it is a silty, calcareous bed 20 inches thick with the overlying Upper Bakerstown coal 2 inches thick immediately above. Raymond (1908-1910) gave a list of fossils from the type locality of this limestone, but fossils are lacking here.

Cambridge red beds. The name Cambridge was applied by Swartz (1922) to red beds overlying the Cambridge limestone. These beds in the New Florence quadrangle are irregular in thickness, position and continuity. They occur as a solid bed up to something over 20 feet thick or in thicker zones alternating with gray and greenish shales. Outcrops are commonly poor and the red beds appear as soft, brick red clay or as fragments of purplish-red gritty shale. Numerous poor exposures of the Cambridge red beds were seen in the Ligonier syncline, particularly where they crop out on the limbs of that structure south of the Conemaugh River and may be seen at the following selected localities: North (Cb 21) and east (Bc 1) of Ross Mountain Park and south of Luther School (Bc 26).

Lower Bakerstown coal and Cambridge limestone. These members are prominent in some parts of southwestern Pennsylvania but are unimportant in this area. The Lower Bakerstown coal was not seen at outcrop. Indication of its presence is shown on some of the sections of core drill holes (Plate 2) wherein a few inches of bony coal or coal occur at about 200 feet above the Upper Freeport coal.

Calcareous beds also are indicated on some of the sections and, lying below the Lower Bakerstown coal, probably represent the Cambridge limestone (Andrews 1873). This member is also called the Pine Creek limestone in some other reports, and contains marine fossils in other localities. Raymond (1908-1910). A limestone, determined to be the Cambridge, was seen as weathered nodules containing secondary limonite where it was dug from scattered pits southeast of Fort School (Bc 16). It was learned from natives that the ore was hauled to Ross Furnace at Ross Mountain Park. The furnace was built in 1814 and stands well preserved today.

Meyersdale red beds. The Meyersdale red beds, named by C. K. Swartz (1922) occur in the interval between the Cambridge and Brush Creek limestones. They are present in the New Florence quadrangle, are not restricted to a definite horizon, and are quite similar in character to other beds in the Conemaugh series. As may be seen on Plate 2, red beds are missing between their delimiting horizons in many of the sections. Numerous poor exposures of the Meyersdale red beds were seen in the Ligonier syncline, particularly southwest of the Conemaugh River. A fair exposure may be observed at Factory School (Bb 29).

Buffalo sandstone. This sandstone was first described by White (1878) for the fine outcrops along Buffalo Creek in Butler County, where its stratigraphic position is just above the Brush Creek limestone and coal. The Buffalo sandstone in the New Florence quadrangle is erratic in stratigraphic position, thickness and distribution. As may be noted on Plates 2, 3, the Buffalo sandstone is lacking in some sections whereas in others it fills most of the interval to the horizon of the Cambridge limestone and has replaced the Brush Creek members.

Numerous outcrops of the Buffalo sandstone were observed in the Ligonier Valley, but they are incomplete. The sandstone commonly is fine-medium-grained, greenish-gray and thin-bedded, but at some localities it is strong, massive and coarser-grained. Its resistant massive character is indicated by surficial boulders along U. S. Route 22 east of Ridge School where it contributes to the relatively flat surrounding upland. Fair exposures of outcrops occur near Luther School (Bc 23) and east of Waterford on Pa. Route 271 (Bc 28) where the sandstone is immediately above the fossil horizon of the Brush Creek limestone.

Brush Creek limestone and coal. The Brush Creek limestone and coal was named by White (1878) from their occurrence along Brush Creek in Butler County. The coal is the same as the well-known Gallitzin coal in Blair and Huntingdon counties. The Brush Creek members not only are incredibly widely distributed but maintain their lithologic character and relationship throughout most of southwestern Pennsylvania in the lower part of the Conemaugh series. The limestone has also been recognized in Maryland, West Virginia and Ohio.

The graphic sections of core drill holes in the New Florence quadrangle (Plates 2, 3) reveal the generally persistent nature of these relatively thin members. They are valuable horizon markers, but unfortunately are concealed at outcrop and only a few exposures were found. However, the associated black shale was useful in locating their approximate position at the weathered outcrops. The Brush Creek limestone lies about 100 to 150 feet above the Upper Freeport coal. It is dark gray to dull black, dense, hard, abundantly fossiliferous and does not exceed 12 inches in thickness. The marine fossils have not been identified in this area. Raymond (1908-1910) gives a list of fossils in the Brush Creek limestone from a few localities in southwestern Pennsylvania and the fauna is characterized by abundance of *Chonetes verneuilanus* c, *Bulimorpha nitidula* c, *Lophophyllum profundum* c, *and Griffithides sangamonensis.*

The coal lies immediately below the limestone and is normally separated from it by a few feet of black shale. Its known maximum thickness in the area is 15 inches; a variable thickness of plastic clay commonly underlies the coal. Following are the better exposed sections of the Brush Creek coal, limestone and associated beds:

Section northwest of New Florence (Bb 27)

	Ft.	*In.*
Shale and interbedded sandstone	10 +	
Shale, black, fissile	8	0
Limestone, dark gray, hard, fossiliferous	1	0
Shale, black, fissile	0	10
Coal, impure	0	9
Shale, black, fissile	1	0
Shale, carbonaceous	0	4
Clay, plastic, gray	6 +	

Section southwest of Lockport (Bb 22)

	Ft.	*In.*
Sandstone, thin and shaly, Buffalo	10 +	
Shale, black, fissile in lower part	15	0
Shale, dark calcareous, fossiliferous	0	6
Limestone dark gray, hard, dense, fossiliferous Brush Creek	1	0
Shale, olive drab and dark	40	0
Shale, black, fissile	0	7
Shale, dark gray	2	0
Coal, bony, Mahoning	1	0
Shale, clayey, olive drab, nodules of semi-flint clay	13	0
Shale, clayey, light olive drab, limonite nodules	10	

Section northwest of Robindale (Cb 1)

	Ft.	*In.*
Sandstone, Buffalo	10	
Limestone, dark gray	0	8
Shale, black, fissile	0	5
Limestone, dark gray, dense, hard	0	8
Shale, black, fissile	15	0
Shale, and shaly sandstone	5	0
Sandstone, dark, fine-grained, flaggy		

Mahoning members. The interval between the Brush Creek and Upper Freeport coal (100 to 150 feet) is extremely variable in composition (Plates 2, 3). Shales dominate the section at some places whereas sandstones are the dominant material at other places; minor nonpersistent carbonaceous, calcareous and clayey deposits are also present in various parts of the section. As indicated in three core drill holes northwest of Armagh (Plate 3, sections 12, 13, 14) a sequence of coal, clay and limestone is locally developed in the Upper part of the Mahoning section. The coal (Hager coal of Somerset County) varies from 24 to 44 inches thick and was reportedly opened in this locality but is of poor quality. The limestone has a maximum indicated thickness of 5 feet. The Mahoning coal is 12 inches thick where it is exposed at outcrop southwest of Lockport Station (Bb 22). A test pit southeast of Luther School (Bc 25) showed that it is 30 inches thick, but poor in quality.

The sandstones in the upper part of the Mahoning section are usually weak and very erratic in occurrence and probably for the most part represent filled channels. The sandstone lying immediately above the Upper Freeport coal is the lowest member of the Conemaugh series and, although it is undeveloped at some places, it has a wide distribution in western Pennsylvania. This lower Mahoning sandstone is missing in some localities in the New Florence quadrangle, but it is generally a strong, massive deposit and is a conspicuous feature of the geology where these resistant rocks crop out.

The physical characteristics of the Mahoning sandstone vary vertically and horizontally. The color phases are greenish, various shades of gray and whitish. The texture grades from fine to coarse and is locally finely conglomeratic; minute mica flakes, plant impressions and limonite in the form of balls and irregular ribbons are not uncommon. The bedding planes are usually irregular, occasionally parted by lenses of shale, and foreset beds are conspicuous. It was noted at many places that the base of the sandstone lies on an unevenly eroded surface of shale; and sandstone locally cuts into and through the Upper Freeport coal bed. The observed maximum thickness of the sandstone is 50 feet.

Fine exposures of the Mahoning sandstone were seen in the high walls of strip mines North of U. S. Route 22 where it caps the hilltops on the Chestnut Ridge anticline. Outcrops of the sandstone continue southwestward on the west limb of the anticline. An unconformity at the base of the Mahoning is excellently displayed in a strip mine south of Strangford (Aa 52). The massive resistant character of the sandstone is exhibited by conspicuous large boulders along the west and east branches of Richards Run northeast of Robinson. It is very well displayed in a bold cliff south of Lockport and is there 50 feet thick. As indicated by minor outcrops, the sandstone has a generally lesser development in the northeastern part of the quadrangle. The Mahoning appears to be continuous as a resistant sandstone along the east side of Ligonier Valley south of the Conemaugh River, and good exposures occur at Ross Mountain Park (Bc 3, 4).

Allegheny Series

General discussion. The Allegheny series is so named for the excellent display of these rocks along the Allegheny River north of Pittsburgh. Some of the important units in the series were named for towns along the river. The Allegheny series was formerly called the "Lower Productive" coal measures because it contains several valuable coal beds.

As customarily mapped, the limits of the series extend from the top of the Upper Freeport coal to the base of the Brookville coal. Because of the uncertain identity, discontinuity, and erratic nature of the Brookville coal, it is unfortunate that this horizon was used to mark the lower limit of the Allegheny series and is so well established in the literature. Studies of the rocks of the Pennsylvanian system in western Pennsylvania show that the Lower Kittanning coal bed in the lower part of the series is more persistent in thickness and continuity and would therefore have been a more definite horizon to limit the base of the Allegheny series.

Rocks of the Allegheny series in the New Florence quadrangle crop out in bands of irregular outline in the foot hills on the sides of Laurel Hill. They have a similar pattern of outcrop on the west side of Chestnut Ridge south of the Conemaugh River; but on the east side of the ridge they form a narrow strip in a fault zone with steep southeast dips, and the breadth of outcrop is only a little more than the thickness of the series. North from the Conemaugh River, these rocks occur on the lower slopes of Chestnut Ridge with remnants capping the crest. As the axis of the anticline plunges northeastward, they increasingly rise into the upland, and from U. S. Route 22 northeastward, the entire thickness of the series is exposed over wide areas to the northern boundary of the quadrangle. The continuity of these strata is interrupted where Blacklick Creek has cut through them. The Allegheny rocks crop out in the bluffs along Blacklick Creek eastward, following short distances as reentrants up the tributary streams and they rise gradually into the upland on the plunging axis of the Nolo anticline at the northeast.

Rocks of the Allegheny series are nowhere completely and continuously exposed along their line of outcrop in the quadrangle. The lower part is exposed in a cut on the main line of the Pennsylvania Railroad on the west limb of Chestnut Ridge east of Torrance where the thickness is about 228 feet. The graphic section is shown on (Plate 5, section 2); descriptive details are given below.

The Torrance section was measured by Fettke and Bayles (1944). Some modifications were made by the author. The maximum known thickness of the series in the quadrangle is 260 feet which is revealed in a core drill hole southwest of Blacklick. (Plate 2, section 3). Core drill holes in the northeastern part of the quadrangle indicate a thickness of 220 feet (Plate 2, sections 17, 18; Plate 3, sections 8, 9, 10). The series is 240 feet thick in a core drill hole northwest of Robindale (Plate 4, section 18); and a core drill hole in the southeastern part of the quadrangle on the east side of Laurel Hill shows the series to be 210 feet thick (Plate 2, section 24).

Section of Allegheny series at Torrance 228 feet thick
(After Fettke and Bayles)

Thickness feet		*Cumulative thickness in feet*	
		Top	*Bottom*
3.5	Coal, Upper Freeport	0	3.5
26.5	Concealed	3.5	30.0
65.0	Sandstone, fine-medium-grained, gray thick-bedded	30.0	95.0
26.0	Shale, greenish gray, sandy fissile	95.0	121.0
1.7	Coal, Upper Kittanning	121.0	122.7
14.2	Shale, dark greenish gray, sandy, fissile containing abundant plant remains	122.7	136.9
6.8	Shale, grayish black fissile	136.9	143.7
1.0	Coal, bony, Middle Kittanning	143.7	144.7
2.5	Clay, light gray, with siderite concretions	144.7	147.2
2.0	Siltstone, light greenish gray, micaceous	147.2	149.2
1.0	Sandstone, very fine-grained, light greenish gray	149.2	150.2
4.7	Shale, greenish gray, sandy and micaeous containing siderite concretions	150.2	154.9
27.0	Shale, dark to very dark gray, silty, fissile containing siderite concretions	154.9	181.9
3.5	Coal, Lower Kittanning	181.9	185.4
9.0	Shale, very dark gray, silty and carbonaceous	185.4	194.4
16.0	Clay, light gray, with calcareous concretionary zone	194.4	210.4
11.0	Shale, gray, fissile	210.4	221.4
2.0	Shale, greenish gray silty	221.4	223.4
5.0	Shale, greenish gray, sandy	223.4	228.4

The Allegheny series is characterized by repeated depositional sequences, some of which locally are complete cyclothems (Plates 2, 3, 4). Shale is the dominant rock type in the section throughout the area, but sandstone is present locally in approximately equal amounts. Lateral gradation, which is another characteristic of the series, is illustrated graphically in a fence diagram (Plate 6) which includes a relatively small area in the northeastern part of the quadrangle.

The Allegheny series in western Pennsylvania contains at least seven economically important coal beds. They are in downward stratigraphic order as follows: Upper Freeport "E", Lower Freeport "D", Upper Kittanning "C′ " or "C prime", Middle Kittanning "C", Lower Kittanning "B", Clarion "A′ ", and Brookville "A". Only the Upper Freeport, Lower Freeport and Lower Kittanning coals have importance in the New Florence quadrangle and have been exploited commercially. Clay deposits of variable thickness and quality usually underlie the coal beds, as occasionally do argillaceous freshwater limestones. Minor ores of limonite and siderite also are present.

The members of the Allegheny series present in the New Florence quadrangle and their order in the section are as follows:

Members of the Allegheny series

Upper Freeport coal
Upper Freeport clay
Upper Freeport limestone
Bolivar fire clay
Butler sandstone

Lower Freeport coal
Lower Freeport clay
Lower Freeport limestone

Freeport sandstone
Upper Kittanning coal
Upper Kittanning limestone
Upper Kittanning clay
Kittanning sandstones
Middle Kittanning coal & clay
Lower Kittanning "B" rider coal & clay
Lower Kittanning clay
Lower Kittanning coal
Clarion sandstone
Brookville coal

Following is a brief discussion of the members. Those having present and future economic value are described in greater detail in the Mineral Resources sections.

Upper Freeport ("E") coal, clay and limestone. The Upper Freeport coal which marks the top of the Allegheny series is, from available information, well developed in three distinct areas in the New Florence quadrangle. Surface and subsurface information indicates that it is thin or missing over a large area in the northeastern part of the quadrangle north of the Conemaugh River. The horizon is deeply buried in a very large area in the Ligonier syncline south of the Conemaugh River where test drilling, if any, is not known to have been done. In the areas of known development the coal is normally about 4 feet thick and commonly contains one or more partings or binders in the lower part and lenses of pyrites and fusain occur in various parts of the bed. Test holes and mining operations reveal extremes from zero to a bed thickness of about 10 feet and, where it has attained its maximum thickness for the area, the bed is divided into two benches by up to 18 inches of bony coal or shale at the middle.

The Upper Freeport coal has undergone large scale commercial deep and strip mining at the northwest, particularly near Coral and Strangford. Core drill holes disclose that persistently minable coal still underlies a large area and very large reserves have been estimated. Commercial mines have worked the Upper Freeport coal at Bolivar and Lockport for many years but sizable recoverable reserves still remain. The presence of minable Upper Freeport is indicated by a few country banks in the foot hills of Laurel Hill in the vicinity of Ross Mountain Park.

A variable amount of plastic clay usually underlies the Upper Freeport coal. Apparently because of the availability of better quality clays in the lower part of the Allegheny series, this clay has had little interest, hence surface information about it is meager. The top of the clay is exposed in strip mine pits in the northern part of the quadrangle and, insofar as the upper part is concerned, good quality clay may be available in some quantity. Clay is also indicated below the Upper Freeport in many of the core drill holes in that area.

The Upper Freeport limestone lies immediately below the underclay of the coal bed. It is missing or poorly developed over large areas in the quadrangle and is represented as nodules where exposed at outcrop. The limestone was formerly worked for agricultural lime at some places and, from reported information, it occurs in two or more layers separated by shale, totaling up to 8 feet thick.

Bolivar fire clay. The type locality of this clay is at Bolivar (White 1891), in the New Florence quadrangle where it had been mined for manufacture of fire brick. The top of the bed is about 11 feet below the Upper Freeport coal, and immediately below the limestone. It has been confused with the underclay of the Upper Freeport coal in some regions. The Bolivar clay ranges from 3 to 12 feet thick, including varying amounts of plastic and flint clay (hard flint-like clay) which is replaced almost abruptly by sandy shale. Concretions of siderite (iron carbonate) are scattered throughout and where abundant, they render the clay worthless. Typical Bolivar clay apparently is not present elsewhere in the quadrangle.

Butler sandstone. The Butler sandstone, which was named by White (1878), lies between the Upper Freeport and Lower Freeport coal beds. Weak, inconspicuous sandstone is locally present at this place in the section of the Allegheny in this area. A gray to greenish-gray, fine-medium-grained, thin-bedded sandstone containing some mica is above the Lower Freeport coal where it was strip-mined on Chestnut Ridge north of Pa. Route 22. South of New Florence, a gray to whitish, medium-coarse-grained hard sandstone about 15 feet thick comes to the surface just south of the old iron furnace. It lies below the Upper Freeport coal horizon, and its apparent local development suggests a filled stream channel.

Lower Freeport ("D") coal, clay and limestone. Information concerning the Lower Freeport coal is restricted almost exclusively to the area of the quadrangle north of the Conemaugh River where numerous core drill holes have penetrated the horizon. The coal has an apparent persistent minable thickness and is developed commercially in the area north of U. S. Route 22, and roughly delineated by Armagh at the east, Ridge School at the west, and Blacklick Creek at the north. The bed thickness ranges from 24 to 54 inches, but averages about 40 inches thick, and contains one or two irregularly spaced partings or binders up to three inches thick. The coal apparently becomes progressively thinner to the east, west and north of this area. Lower Freeport coal of minable thickness is indicated near Lockport along the Conemaugh River.

Plastic clay in varying amounts occurs under the Lower Freeport coal in the majority of the core holes in the northern part of the quadrangle, and light, bluish-gray plastic clay was noted under the coal where it was strip-mined. The clay apparently has not been exploited in this area.

The Lower Freeport limestone which lies below the underclay has a spotty occurrence in this area. It is recorded in some core holes north of the Conemaugh River, and has been mined in drifts and open pits north of Robinson (Ba 45, Bb 6), near Lockport and reportedly is 4 to 5 feet thick.

Upper Kittanning ("C′") coal, clay and limestone. The presence of these members in the New Florence quadrangle is known almost entirely from core drill holes in restricted areas, and they occupy a position approximately 80 feet below the Upper Freeport coal (Plates 2, 3, 4). The Upper Kittanning is important in some parts of the bituminous coal fields but where tests holes were drilled in this area, it does not have present economic value, and is generally missing. A few of the core drill sections show a variable amount of underclay with the Upper Kittanning coal but the quality is not indicated.

The Upper Kittanning limestone lies immediately below the coal bed. It also is called the Johnstown cement bed because of its impure composition in the Johnstown region. This member is absent or only locally developed where core drilling has penetrated the horizon in the quadrangle. Minor limestone was found in drill holes north of Seward. (Plate 3, sections 24, 25.) Its local occurrence is indicated in a hole northeast of Strangford. (Plate 2, section 12.) Upper Kittanning limestone is reported, but is not exposed on the west branch of Richards Run northeast of Robinson. On the east side of Laurel Hill core drill holes show a good development of the Upper Kittanning stone (Plate 4, sections 24, 26-29).

Freeport and Upper Kittanning sandstones. The Freeport sandstone lies between the Lower Freeport and the Upper Kittanning coals. The Upper Kittanning sandstone lies between the Upper Kittanning and Middle Kittanning coals. Most of the sections in the New Florence quadrangle (Plates 2, 3, 4) show variable amounts of sandstone occupying irregular stratigraphic positions in the interval between the Lower Freeport and the Lower Kittanning coals. Sandstone deposits up to 115 feet thick are present locally, and sandstone has replaced the limiting horizons at various places.

The Freeport sandstone commonly is a local development, but it also locally coalesces with the Upper Kittanning sandstone below, replacing the Upper Kittanning coal and associated members.

The Upper Kittanning sandstone is most everywhere present in some degree of development. As evidenced in the accompanying section, the base of this sandstone appears to lie on an unevenly eroded surface. The Upper Kittanning sandstone is fine-medium-grained, gray, greenish-gray and grayish-white. It is usually thick-bedded with relatively thin beds at the bottom having undulating lamination. Its resistant character is indicated by massive boulders along the outcrop. The Upper Kittanning sandstone is conspicuously displayed in the section along the Pennsylvania Railroad east of Torrance, where it is about 65 feet thick. It continues as a conspicuous sandstone cropping out the western foot-hills of Chestnut Ridge to the south. Its continuity north of the Conemaugh River is indicated by numerous partial outcrops and, influenced by the plunging axis of the anticline, it crops out in the higher parts of Chestnut Ridge south of U. S. Route 22.

Outcrops of the Upper Kittanning sandstone are present at various places in the valley and the hills adjacent to Blacklick Creek. This sandstone is well developed and appears to be continuous on the west foot hills of Laurel Hill. It is partly exposed in a small quarry on Baldwin Creek southeast of New Florence (Cb 20), where the sandstone overlies the Lower Kittanning "B" rider coal.

Middle Kittanning ("C") coal. A commonly thin, nonpersistent coal occurring from 50 to 75 feet above the Lower Kittanning appears in some of the sections plotted from core drill records (Plates 2, 3, 4). The sequence and the position of this coal bed corresponds to the Middle Kittanning of the Allegheny Valley; it is called the "slate vein" in Center County and the "Seymour" in the Blossburg basin. Although it thickens locally, the coal is not known to have been worked in the New Florence quadrangle. The core sections show variable thicknesses of plastic underclay.

Lower Kittanning ("B") rider coal. Most of the core drill holes that penetrated rocks of the Allegheny series to the Lower Kittanning coal (Plates 3, 4) have found a coal bed lying usually from 20 to 30 feet above the Lower Kittanning; it also was revealed in the high walls of some of the strip mines on the Lower Kittanning. A coal at a similar position in the section in Cambria County is called the "B" rider. The "B" rider in the New Florence quadrangle is usually from 18 to 30 inches thick and is persistent in certain areas. Some small deep mines have worked the bed and some of it has been strip-mined, but it is not considered to have present commercial value. However, this coal does represent a future potential mineral resource and is discussed in some detail in the section of mineral resources.

Plastic underclay is usually present and a limestone, reportedly 4 to 14 feet thick, lies below the coal in one locality.

Middle Kittanning sandstone. A variable thickness of gray to black shale containing scattered siderite concretions normally overlies the Lower Kittanning coal, but a few sections (Plate 4, sections 3, 11, 12, 17, 25) show sandstone immediately above or in contact with the coal bed. Deep mine workings have encountered sandstone cutting into and through ("faults") the Lower Kittanning which is the result of cutting and filling. Surface exposures show minor sandstones above the roof shales of the Lower Kittanning but in some localities a thick section of gray, medium-grained relatively thick-bedded sandstone overlies the coal bed which probably is an expanded lower part of the Upper Kittanning sandstone. Such a condition appears to have been obtained in the northwestern part of the quadrangle east of Josephine on the north side of Blacklick Creek (Aa 9) where 20 feet of gray and dark shale overlie the Lower Kittanning coal, which in turn is overlain by about 40 feet of gray, medium-grained, slabby sandstone. This sandstone is also the cap rock of the Lower Kittanning on the opposite side of the creek. Sandstone is indicated at outcrop above the Lower Kittanning at various places to the east. Approximately 60 feet of gray medium-grained sandstone is above the coal where it was strip mined northeast of Heshbon (Ba 13) and "rock faults" have seriously affected deep mining at this locality.

Lower Kittanning ("B") coal and clay. From the standpoint of continuity and uniform distribution, the Lower Kittanning is generally considered to be the most valuable coal bed in the Allegheny series in western Pennsylvania and, since depletion of the Pittsburgh coal in the New Florence quadrangle, the Lower Kittanning is certainly the most valuable bed in this area.

Surface and subsurface data show large areas underlain by uniformly minable Lower Kittanning in the northern part of the quadrangle, and by reason of its persistent habit, it can be inferred with some degree of safety that larger additional reserves would be found where the coal horizon underlies the greater untested areas. The Lower Kittanning has been exploited commercially in the quadrangle since the beginning of the century and still is being mined to some extent, but the total coal produced thus far represents only a small fraction of the recoverable reserves.

Although there are some minor local "cut outs" and thickness reductions, the coal maintains a fairly uniform thickness which ranges normally from about 36 to 48 inches, with a known extreme of 60 inches. The bed is characteristically topped by a variable thickness of "bony"; it is locally free of visible impurities, but commonly containing one or more partings and binders separating the bed into benches of variable thickness. Visible sulfur, largely in the form of pyrite, occurs as balls, lenses and disseminated minute particles; lenses of fusain or "mother coal" are also common.

The Lower Kittanning coal is usually underlain by plastic clay. The majority of the core drill holes that tested the coal, were bottomed immediately below it and therefore do not show the full thickness of the underclay. Large quantities of this clay have been uncovered in strip mine pits and, although only the upper part of the deposit was open for inspection, good quality clay is usually indicated. Lower Kittanning clay was mined and used for the manufacture of bricks at Bolivar.

Vanport Marine limestone. The Vanport limestone, which occurs at an interval of approximately 40 feet below the Lower Kittanning coal, has a wide distribution in the northern part of the bituminous coal fields of western Pennsylvania. Because of its abundant fossil content, it is easily identified and is therefore a valuable key rock in mapping the geology. This limestone also has economic importance in the areas of thicker development.

The Vanport limestone was nowhere observed where its horizon crops out in the New Florence quadrangle. Probable minor representation is indicated in two core drill holes located near Robindale in the northeastern part of the quadrangle (Plate 4, sections 18, 23). The details of the sections from the Lower Kittanning coal down to the top of the Homewood sandstone (Pottsville) are given below. In the sections, a thin limestone lies above thin bony coal at about 35 feet below the Lower Kittanning coal, which is the Lower Kittanning-Vanport stratigraphic relationship. The limestone-over-coal sequence in the sections suggests that calcareous material was possibly deposited under marine conditions.

Section of core drill hole (Ca 72)

	Ft.	*In.*
Coal, Lower Kittanning	3	1
Clay, plastic	9	2
Shale, gray	4	11
Sandstone	4	0
Shale, gray	10	0
Shale, dark	9	0
Limestone, Vanport	1	6
Shale, dark	1	6
Coal, Clarion	0	2
Clay	0	2
Shale, dark	29	8
Coal, Brookville	0	8
Clay	5	0
Shale, gray	5	9
Shale, gray, sandy	9	9
Sandstone, pebbly, Homewood	21	6

Section of core drill hole (Cb 14)

		Ft.	*In.*
Coal, Lower Kittanning		3	4
Shale, dark		1	1
Bony and shale		0	6
Shale, light, sandy		1	4
Shale, dark		0	5
Clay		9	11
Shale, light, sandy		10	1
Sandstone		16	5
Limestone, Vanport		0	9
Coal and Shale		0	6
Shale, dark, sandy		0	5
Sandstone		17	0
Coal and Shale	Brookville	0	7
Shale, dark		7	3
Coal		0	2
Clay		1	11
Shale, dark, sandy		17	1
Sandstone, Homewood			

Clarion sandstone. The Clarion sandstone lies between the Lower Kittanning and Brookville coal beds. A prominent sandstone is present in this interval, at least locally, in the northern part of the quadrangle (Plate 3, sections 1, 3, 6, 10). This sandstone crops out in a good exposure on Pa. Route 56 at Dias where it is gray, medium-grained, medium-thick-bedded and about 50 feet thick. The sandstone has a similar lithology and is about 40 feet thick in the railroad cut west of Scottglen (Ca 37).

Brookville "A" coal. A coal bed lying from 30 to 70 feet below the Lower Kittanning and just above the Homewood sandstone is tentatively taken to be the Brookville in the New Florence quadrangle. Data on this coal are meager but indications are that the bed is generally thin or missing. A few core drill holes have penetrated the horizon at various places (Plates 2, 3, 4). The Brookville may have a workable thickness of some extent where it was strip-mined northeast of Josephine (Ba 3), and has a bed thickness from 42 to 46 inches. A core drill hole put down southwest of Blacklick (Aa 36) found it to be 40 inches thick, and a thickness of 34 inches is reported in a drift west of Heshbon (Ba 19). The Brookville consists of 30 inches of impure coal where it is exposed in the railroad cut west of Scottglen.

Pottsville Series

General Discussion. The Pottsville series is represented in the New Florence quadrangle and consists of three main divisions: The Homewood sandy upper division, the Mercer, shale, clay and coal at the middle and the Connoquenessing sandy lower division with the Quakertown coal at the base locally. Outcrops of the Pottsville series are confined mainly to the anticlinal mountains where hard resistant sandstones give these topographic features their rugged character. They form sheer cliffs in many of the steep-sided ravines and crop out as bold escarpments on the spurs. These features are particularly striking on aerial photographs when viewed stereoscopically. Residual acidic soil from Pottsville sandstones supports dense laurel thickets at many places on the mountain sides.

Rocks of the Pottsville series crop out in an irregular pattern on the east and west slopes of Laurel Hill. On the east side of Chestnut Ridge south of the Conemaugh River these rocks crop out in a strike-fault zone, and dipping steeply to the southeast, form a narrow irregular hogback. Remnants of the lower part cap the knobs on the crest of the ridge, and on the normally dipping western slope, the outcrop pattern is similar to that on the slopes of Laurel Hill. The entire thickness of the series is exposed where the gorge of Blacklick Creek crosses Chestnut Ridge anticline, forming an arch with a base approximately four miles long. The Nolo anticline at the northeast has raised the upper part of the Pottsville above Blacklick Creek from near Dias to Scottglen.

Individual units of the Pottsville sandstones vary in composition from place to place; but they have generally similar characteristics. Strong, massive rocks are usually the rule, and quartzite beds have been noted, but they may also be poorly cemented and friable in parts. They are gradational from fine-through medium-coarse-grained and conglomeratic, with quartz pebbles up to one-half inch in diameter. At some places the pebbles are coated with frosty, secondary silica. The color shades vary horizontally and stratigraphically, they are greenish-gray, light to dark gray and white. Pure quartzose sandstone beds are not uncommon. Limonite staining is usually developed in the zone of weathering; limonite is also present in irregular lenses, and in weathered-out nodules leaving rounded pits on exposed surfaces. Scattered mica flakes may occur on bedding planes, and are more abundant in the thin-bedded, fine-grained layers. Carbonaceous inclusions are present at some places as are plant impressions, particularly stigmaria; stylolites were also observed.

A complete section of the Pottsville series, about 170 feet thick, is exposed in the railroad cut at Torrance (Plate 5, section 2.) Descriptive details are given below. The thickness is estimated to be 175 feet along Blacklick Creek gorge across Chestnut Ridge. A core drill hole went through the Pottsville northeast of Robindale (Plate 4, section 18) and it shows a thickness of 200 feet. Fettke and Bayles (1945), give 197 feet for the thickness of the Pottsville on the west side of Conemaugh gorge southeast of Cramer in the Johnstown quadrangle (Plate 5, section 1). Descriptive details of the section are given below. The coal at the top of the section which these authors correlate as Brookville, was traced into the mines working the Lower Kittanning coal at Boltz a short distance to the east. The lowermost part of the Allegheny series may have been removed by erosion prior to deposition of Lower Kittanning coal. This condition appears to prevail for several miles southwestward along the west limb of Laurel Hill.

Section of Pottsville series southeast of Cramer
(After Fettke and Bayles)

Thickness feet		*Cumulative thickness in feet* *Top*	*Bottom*
45.0	Sandstone, medium grained, light gray, quartzose containing, some plant remains and stylolites. Homewood	0.0	45.0
21.0	Concealed, Mercer	45.0	66.0
38.0	Sandstone, medium-grained, light gray, containing plant remains and stylolites, Connoquenessing	66.0	104.0
70.0	Concealed	104.0	174.0
2.0	Shale, very dark gray	174.0	176.0
.2	Coal, Quakertown	176.0	176.2
8.0	Claystone, light gray, silty	176.2	184.2
3.0	Shale, very dark gray, fissile	184.2	187.2
.7	Claystone, gray	187.2	187.9
1.0	Clay, light greenish gray, silty	187.9	188.9
6.0	Sandstone, fine-grained, light gray	188.9	194.9
1.1	Clay, light gray, sandy	194.9	196.0

The section of the east side of Chestnut Ridge near the southwest boundary of the quadrangle (Ac 8) is complicated by faulting, but a thickness of 170 feet is indicated for the Pottsville series.

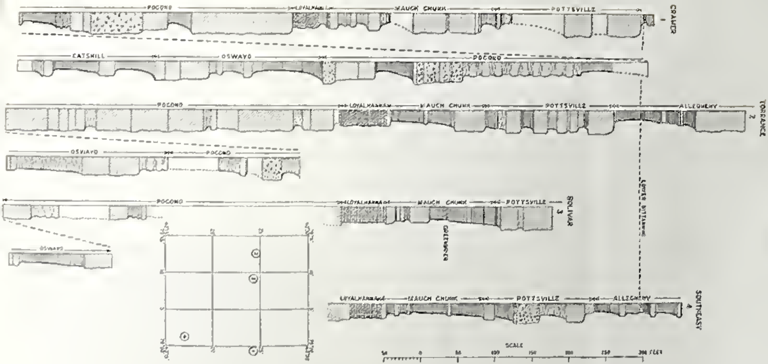


PLATE 5. STRATIGRAPHIC SECTIONS

Section of Pottsville series at Torrance
(After Fettke and Bayles)

Thickness feet		*Cumulative thickness in feet* *Top*	*Bottom*
37.0	Sandstone, fine-medium-grained, light greenish gray, massive Homewood	0	37.0
3.0	Shale, gray, fissile	37.0	40.0
1.7	Coal	40.0	41.7
5.0	Clay, light gray } Mercer	41.7	46.7
4.5	Clay, dark gray } Mercer	46.7	51.2
13.3	Sandstone, fine-grained, light greenish gray, somewhat micaceous, lenticular, Connoquenessing	51.2	64.5
5.7	Shale, light greenish gray, silty possible fault	64.5	70.2
10.0	Sandstone, fine-medium-grained light gray massive, Connoquenessing	70.2	80.2
14.5	Shale, dark gray, silty, fissile	80.2	94.7
15.5	Sandstone, fine-grained, light gray, thick-bedded, Connoquenessing	94.7	110.2
7.0	Shale, gray, sandy, containing plant remains	110.2	117.2
15.0	Shale, dark	117.2	132.2
20.0	Sandstone, gray to dark gray, medium-grained, Connoquenessing	132.2	152.2
15.0	Shale, dark, Coal bloom, Quakertown	152.2	167.2

Homewood sandstone. The Homewood sandstone was named by White (1878) for its occurrence at Homewood Station, Beaver County, Pennsylvania. This upper member of the Pottsville series in the New Florence area lies immediately below the Brookville coal and underclay. It normally occurs as a single unit about 30 to 40 feet thick, but some core drill records show up to nearly 75 feet of solid sandstone (Plate 2, section

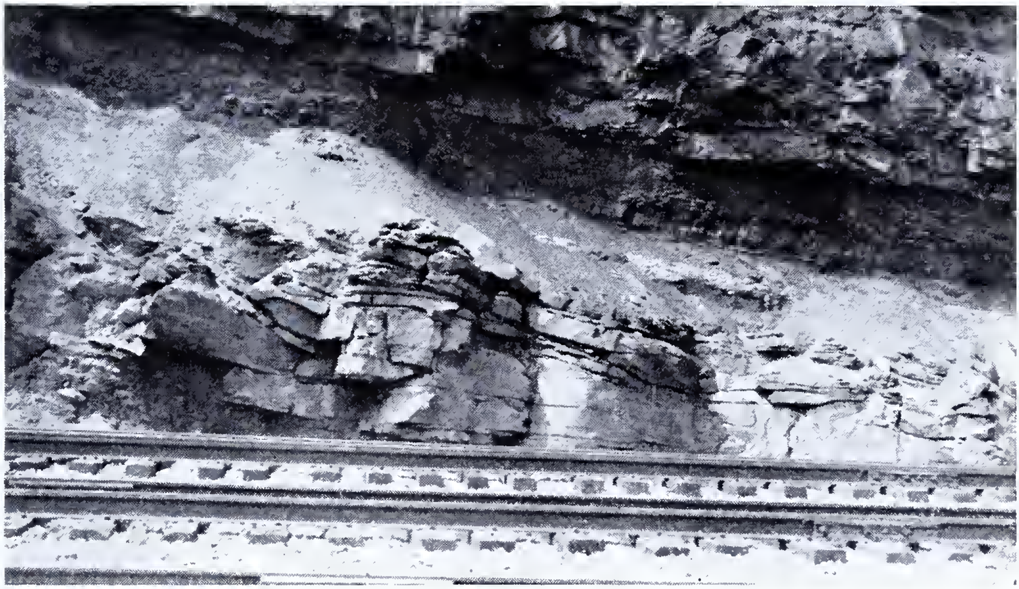


FIGURE 5. Base of Homewood sandstone, Mercer coal and clay, top of Connoquenessing sandstone on Pennsylvania Railroad east of Torrance.

17, Plate 3, sections 8, 9). The Homewood sandstone is well developed and persistent on the east and west limbs of Laurel Hill anticline and its structural dip approximately conforms with the slope of the spurs for relatively long distances, particularly on the west limb of the anticline. It is well displayed in a quarry southeast of Ross Mountain Park (Cc 2) where stone was obtained for construction of nearby Tubmill Reservoir Dam. The rock is grayish-white, medium-grained and contains infrequent lenses of small quartz pebbles and minor lenses of concretions of limonite. The upper part of it is slabby and cross-bedded, becoming progressively thicker-bedded toward the base. The deposit is about 30 feet thick.

An active quarry in the Homewood, producing crushed stone for road metal, is located on the east side of Laurel Hill north of Pa. Route 271 (Cc 3). About 25 feet of the sandstone is exposed in the quarry wall and its character is similar to its occurrence in the quarry on Hulls Run.

Emerging from the bed of the Conemaugh River near the mouth of Richards Run, east of Bolivar, the Homewood rises toward the Chestnut Ridge anticline and makes a bold bluff about 30 feet high near the mouth of Tubmill Creek. The upper part of the sandstone is here thin-bedded, fine-grained and micaceous, and medium-grained, thicker-bedded in the lower part. From this point southwestward on the east side of Chestnut Ridge, the Homewood sandstone becomes progressively inconspicuous in the fault zone.

In the Torrance section on the west side of Chestnut Ridge the Homewood is fine-medium-grained, light greenish-gray, massive and is 37 feet thick. Its continuity southwestward on the west limb of the anticline is marked by massive boulders. The sandstone maintains its resistant, massive character where it crops out on the Chestnut Ridge anticline north of Conemaugh River to near U. S. Route 22, and it is still a prominent sandstone in the Blacklick Creek gorge across Chestnut Ridge. The Nolo anticline at the northeast has also raised the Homewood sandstone above Blacklick Creek.

Mercer group. The Mercer group which occupies the middle part of the Pottsville series was named for its occurrence in Mercer County, Pennsylvania (White 1878). The group contains important plastic and flint clays at various places in western Pennsylvania. Rubble from the overlying Homewood sandstone usually conceals the outcrop of the Mercer group in this area, and little information concerning it was obtained. A fine exposure of the group is in the railroad cut east of Torrance in which the following section was measured:

Mercer section east of Torrance
(After Fettke and Bayles)

	Ft.		*In.*
Sandstone, Homewood	37	—	0
Shale, gray, fissile	3	—	0
Coal	1	—	7
Clay, light gray	5	—	0
Clay, dark gray	4	—	6
Sandstone, Connoquenessing			

The only known locality where the Mercer clay has been worked is at Bolivar (Bb 11) where it was mined by Garfield Refractories Co., for manufacture of fire brick. The workings are abandoned and inaccessible, but the following information was obtained from an authoritative source.

Mercer section at Bolivar

	Ft.	*In.*
Coal	2	0
Clay, soft, good	5	0
Clay, sandy	3-4	0
Clay, soft	10-12	0

On the east side of Chestnut Ridge near the southwest boundary of the quadrangle (Ac 8) the Mercer group is imperfectly exposed in a fault zone, and shale, clay and thin coal are indicated. Partial exposures of the Mercer occur on the north side of Blacklick Creek east of Dias.

The following are sections of the Mercer group revealed in core drill holes.

Partial section of core drill hole (Plate 2, section 17)

		Ft.	*In.*
Sandstone, conglomeratic, Homewood		68	0
Shale, dark	Mercer	0	8
Coal, bony		1	0
Clay		1	0
Sandstone, hard, white		2	0
Shale, dark		0	10
Clay, soft		3	6
Shale, sandy, green		17	0
Sandstone, green, Connoquenessing		53	0

Partial section of core drill hole (Plate 4, section 19)

		Ft.	*In.*
Sandstone, Homewood			
Clay, impure	Mercer	7	5
Shale, dark		7	6
Coal		1	0
Shale, dark		14	6
Coal		0	2
Shale, black		0	3
Coal, bony		0	3
Shale, dark		14	0
Sandstone, Connoquenessing			

Connoquenessing sandstones. I. C. White (1878) applied this name to sandstones below the Mercer on Connoquenessing Creek in Lawrence County, Pennsylvania. Good exposures of the lower part of the Pottsville series in the New Florence quadrangle reveal two or more sandstone units separated by thinner shale partings, the whole totaling up to a maximum of nearly 100 feet thick (Plate 4, section 18).

A strong massive gray to grayish-white, medium-grained sandstone which is locally conglomeratic is persistent on the east and west limbs of

Laurel Hill anticline. Its contact with the weaker material composing the underlying Mauch Chunk makes conspicuous escarpments well up on the mountain spurs. The exact thickness of this sandstone could not be determined, but it is probably not much more than 30 feet thick. Associated weaker Connoquenessing sandstones, if present, are not exposed.

On the east side of Chestnut Ridge anticline south of the Conemaugh River, southwestward to the boundary of the quadrangle, the Connoquenessing sandstone reflects a strike fault with southeast dips ranging from 40° to 85°. The steep-dipping outcrop forms a prominent hogback extending along the mountain side, and at some places it is plainly visible from various points in the Ligonier Valley to the east.

In a cut along the railroad north of Bolivar the Connoquenessing sandstone is composed of two units. The upper unit is coarse to very coarse-grained and conglomeratic in the upper part, and medium-grained in the lower part; the whole is light gray, massive and 39 feet thick. The lower unit is a fine-medium-grained, light gray, massive sandstone with shale lenses in the middle, and is 23 feet thick, greenish-gray, sandy, micaceous shale 7 feet thick, separates the two units. The material between the base of the lower sandstone unit and the contact with Mauch Chunk is composed of gray, fissile shale, which becomes silty and carbonaceous at the base, and contains abundant plant remains and minute coal lenses.

Connoquenessing sandstone caps the elongated knobs on the crest of Chestnut Ridge south of the Conemaugh River; and north of Bear Pond Hollow enlarged joints in the sandstone form a miniature "Rock City". Low escarpments on the west side of the ridge mark the contact of resistant sandstone with Mauch Chunk shale.

The section at Torrance shows several sandstone units parted by relatively thinner shales comprising the Connoquenessing member. This member is conspicuous in the bluffs along the gorges of the Conemaugh River and Blacklick Creek.

MISSISSIPPIAN SYSTEM

General Discussion

The Mississippian system is composed of three distinctive lithologic divisions. The upper division is the Mauch Chunk series which is composed of alternating red and green shales with interbedded sandstone, and locally contains the Greenbrier limestone. The middle division is the Loyalhanna siliceous limestone, and the lower is the Pocono sandstone. The area of outcrop of Mississippian rocks in the New Florence quadrangle is restricted to the Laurel Hill and Chestnut Ridge anticlines. The thickness is about 1,080 feet on Laurel Hill and nearly 600 feet on Chestnut Ridge.

Mauch Chunk Series

General discussion. The Mauch Chunk series is well exposed and is about 130 feet thick on the east side of Chestnut Ridge in the section near the southwest boundary of the quadrangle. It is there dominantly composed of bright red shales alternating with minor green shales. A 4-foot thick, greenish, fine-grained, thin-bedded, micaceous sandstone lies about 45 feet from the top; and a greenish-gray, medium-grained, conspicuously cross-bedded, slabby sandstone 10 feet thick is at the base. The fossiliferous Greenbrier limestone, 4 feet thick, lies in the upper part of the section in the Loyalhanna gorge southwest of this area but is missing here.

Exposure of the Mauch Chunk in the Torrance section is imperfect. The series is about 135 feet thick and contains the fine-grained, greenish gray sandstone in the upper and lower parts. The Greenbrier limestone, if present, is not exposed. The Mauch Chunk measures 120 feet thick in the wall of a quarry in the Loyalhanna siliceous limestone on the north side of the Conemaugh River.

The Mauch Chunk series is excellently exposed on the east limb of Chestnut Ridge anticline along the railroad north of Bolivar where it is 118 feet thick. The detailed section given below was measured and described by Fettke and Bayles (1944) and shows that the lower part of the Mauch Chunk has become increasingly more sandy; and the Greenbrier limestone is present at 47 feet below the top. An excellent example of cut and fill may be seen in a channel sandstone 0 to 5 feet thick and 45 feet wide (Figure 6). Strong drag folds in the Mauch Chunk here may have affected the true thickness.

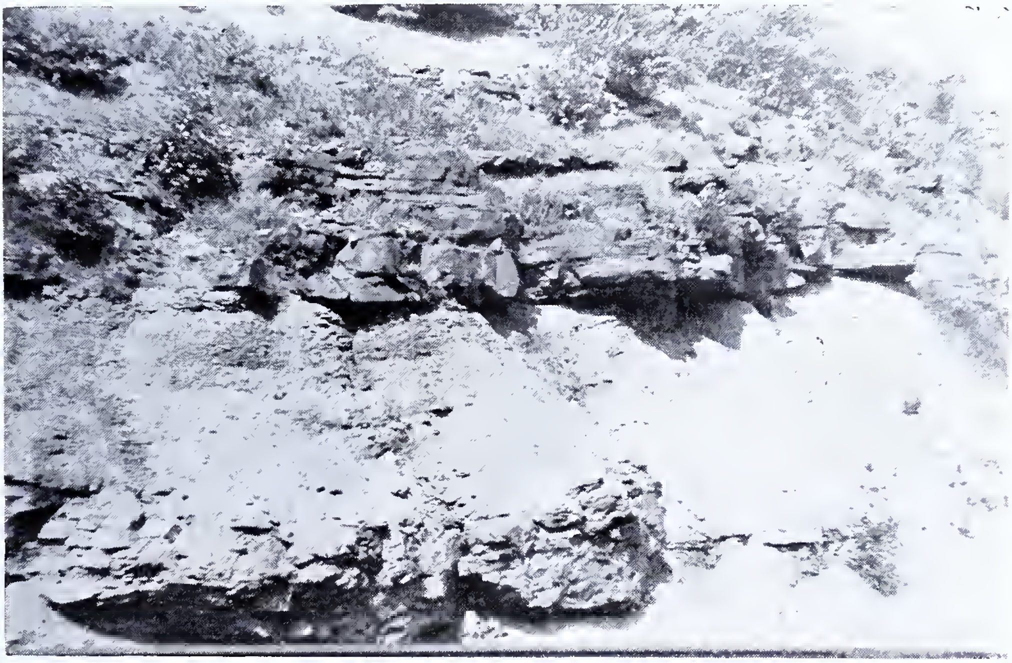


Figure 6. Channel sandstone in Mauch Chunk red beds, on Pennsylvania Railroad north of Bolivar.

Mauch Chunk section north of Bolivar
(After Fettke and Bayles)

Thickness feet		*Cumulative thickness in feet*	
		Top	*Bottom*
16.0	Shale, variegated, grayish green and purplish red	0	16.0
1.0	Siltstone, greenish gray, calcareous	16.0	17.0
30.0	Shale, greenish gray, in part silty	17.0	47.0
6.3	Limestone, dense, gray, shaly, containing abundant fragments of fossil shells, Greenbrier	47.0	53.3
4.0	Shale, light greenish gray, fissile, with interbedded thin seams of dense, gray, fossiliferous limestone	53.3	57.3
2.5	Shale, variegated, greenish gray and purplish red	57.3	59.8
7.7	Shale, greenish gray, with numerous interbedded thin seams of dense, gray, very fossiliferous limestone	59.8	67.5
5.7	Shale, gray	67.5	73.2
26.0	Sandstone, fine-grained, greenish gray	73.2	99.2
3.8	Shale, red	99.2	103.0
3.7	Shale, red, silty	103.0	106.7
5.2	Sandstone, very fine-grained, light greenish gray, with interbedded greenish gray and purplish red shale	106.7	111.9
5.7	Sandstone, very fine-grained, light greenish gray	111.9	117.6

Rocks of the Mauch Chunk series are spectacularly displayed on the west limb of Laurel Hill anticline southeast of Cramer in the Johnstown quadrangle. The graphic section is shown on Plate 5; the detailed section, measured by Fettke and Bayles (1945) is given below. This section shows that the upper part of the Mauch Chunk is dominantly composed of sandstone and the lower part consists of alternating shale and sandstone in approximately equal proportions. The thickness of the series is 211 feet.

Mauch Chunk section southeast of Cramer
(After Fettke and Bayles)

Thickness feet		*Cumulative thickness in feet*	
		Top	*Bottom*
10	Shale, red	0	10
6	Shale, grayish green	10	16
3	Shale, variegated, red and grayish green	16	19
3	Sandstone, very fine-grained, light greenish gray, argillaceous	19	22
5	Sandstone, fine-grained, light greenish gray, containing muscovite	22	27
35	Sandstone, fine-grained, light greenish gray, massive, containing some muscovite	27	62
4	Shale, variegated, red and grayish green	62	66
44	Sandstone, fine-grained light greenish gray, massive containing some muscovite	66	110
30	Concealed	110	140
1	Shale, red	140	141
2	Shale, grayish green, silty	141	143
4	Shale, red	143	147
2	Shale, grayish green, sandy	147	149
5	Shale, red	149	154
16	Sandstone, fine-grained, light greenish gray	154	170
16	Shale, variegated, red and grayish green	170	186
8	Sandstone, fine-grained, light gray	186	194
5	Shale, red	194	199
4	Sandstone, fine-grained, light grayish green	199	203
8	Shale, red, with interbedded fine-grained light grayish green sandstone	203	211

Rocks of the Mauch Chunk series crop out in a zig zag pattern on the east and west sides of Laurel Hill. The outcrop has a similar pattern at the west side of Chestnut Ridge south of the Conemaugh River, and it underlies the elongate knobs on the crest. The outcrop in the steep dips of the fault zone on the east side of the ridge forms a very narrow strip. The Mauch Chunk is completely faulted out at some places on the side of the ridge where Pottsville sandstone is in contact with Loyalhanna siliceous limestone.

Talus from massive Pottsville sandstones conceals the place of the Mauch Chunk in the Blacklick gorge across Chestnut Ridge, but its presence on the east side is indicated by small exposures of weathered red beds. Records of some gas wells located on the Nolo anticline at the northeast show up to 60 feet of red beds at the horizon of the Mauch Chunk (Plate 13, sections 10, 11, 12). Red beds at the position of the Mauch Chunk do not appear on any of the records obtained for wells drilled in the northwestern part of the quadrangle. The base of the Connoquenessing sandstone is concealed on Blacklick Creek on the west limb of Chestnut Ridge anticline, but it appears to be very close to the top of the Pocono sandstone and little if any Mauch Chunk would be present.

The Mauch Chunk series thins to the north and west. Richardson (1904) reports its thickness as 50 feet in the Indiana quadrangle to the north, and it is missing in the Elders Ridge quadrangle (Stone 1905) at the northwest. The Connoquenessing sandstone lies unconformably on the Burgoon sandstone of the Pocono in the northern part of Indiana County (Shaffner, 1946).

Greenbrier limestone. The Greenbrier limestone was named for exposures on the Greenbrier River, Pocahontas County, West Virginia. The limestone commonly is dark, bluish gray, massive-bedded and contains abundant fossil shells.

The Greenbrier is 40 feet thick in Southern Fayette County (Hickok & Moyer 1940), becoming progressively thinner northward. The limestone is 4 feet thick on the west limb of the Chestnut Ridge anticline in Loyalhanna Creek gorge in the Latrobe quadrangle, and is missing where the Mauch Chunk is exposed on the east limb of the Chestnut Ridge anticline near the southwest boundary of the New Florence quadrangle (Ac 2, 8). The Greenbrier is 2 inches thick and lies 15 feet above the base of the Mauch Chunk in a quarry on the Loyalhanna limestone south of Torrance (Ab 6). This bed is concealed, if present in the section southeast of Torrance. In the section north of Bolivar, the Greenbrier is a shaly, gray, abundantly fossiliferous limestone 6 feet thick lying 30 feet above the base of the Mauch Chunk section on the west limb of the Laurel Hill anticline.

Loyalhanna limestone. The Loyalhanna (siliceous) limestone is a massive, cross-bedded rock consisting of grains of quartz cemented by calcium carbonate; it is light to bluish gray on the fresh surface and weathers gray or buff. Cross-bedding is a characteristic feature of the Loyalhanna. This feature is scarcely recognizable on the fresh surface, but becomes strikingly conspicuous where a surface has been exposed long enough to emphasize the inequalities of the individual beds. Due to differential solution, the resistant laminations stand out with curved edges, and the more soluble ones have grooved edges.

The outcrop of the Loyalhanna in the New Florence quadrangle is confined to the Laurel Hill and Chestnut Ridge anticlines where these structures have raised it to the surface. Outcrops of the limestone on the anticlines form almost continuous narrow strips. A relatively soluble rock, and known to be cavernous, it rarely is completely exposed along its natural outcrop. Its position with relation to the enclosing Mauch Chunk shales and Pocono sandstone is marked by a steepening in the slope of the surface, which is visible on the aerial photographs under the stereoscope.

The Loyalhanna is 63 feet thick in the Conemaugh gorge southeast of Cramer in the Johnstown quadrangle where the upper part is interbedded with Mauch Chunk. The following partial section was measured by Fettke and Bayles (1945).

Section of Loyalhanna limestone southeast of Cramer
(After Fettke and Bayles)

	Thickness in feet
Sandstone, fine-grained, light greenish gray, calcareous	11
Limestone, greenish gray, sandy	5
Shale, red with little interbedded grayish green shale	9
Limestone, greenish gray, sandy, cross-bedded	38

A thickness of 40 feet was obtained for the Loyalhanna in a small, long abandoned quarry on the east side of Laurel Hill, just north of Pa. Route 271 (Cc. 7). Exposures of the Loyalhanna were found on the west side of Laurel Hill south from Shannon Run. There is a partial exposure of whitish, medium-grained, massive sandstone at the position of the upper part of the Loyalhanna on Pa. Route 271 (Bc 30). This sandstone is similar to one which lies on top of typical Loyalhanna on Chestnut Ridge to the west, and is believed to be a non-calcareous upper part of the siliceous limestone. The Loyalhanna is exposed in a quarry on the top of Laurel Hill north of U. S. Route 30 in the Somerset quadrangle.

The Loyalhanna is 60 feet thick where it had been quarried in a small way on Chestnut Ridge near the southwest boundary of the quadrangle (Ac 1). About 0.8 of a mile to the south (Ac 8) the top of the Loyalhanna is topped by 1 foot of light gray, dense limestone with a conchoidal fracture. Over it is 5 feet of greenish-gray, medium-grained, cross-bedded sandstone, physically similar to the Loyalhanna, and is considered a non-calcareous upper part of the Loyalhanna.

Major enlargement of joints by solution is evidenced by caves in the Loyalhanna limestone on Chestnut Ridge. The caves were not entered by the author. Detailed description of these caves is given in Bulletin Fifteen of the National Speleological Society, 1953, from which the following locations were taken.

Bear Cave is on the west flank at Chestnut Ridge about 1½ miles east of Hillside and may be reached by following a blazed and well-worn trail from the quarry above Hillside.

Con Cave is on the west flank of Chestnut Ridge 1¼ miles east of Hillside and is about a half mile from Bear Cave.

Coon Cave is on the west side of the crest of Chestnut Ridge at an elevation of about 2,300 feet. It is reached from the quarry above Hillside or by following up Bear Pond Hollow, 2½ miles south of Bolivar.

Copperhead Cave is found by following the old narrow gage roadbed at Hillside to the stream, then following the trails up hill to the blazed trail to the cave.

Lemon Hole may be reached by following the old logging road up Shirley Run. The path to the cave turns off left before the road crosses the creek.

Rattlesnake Cave is found by taking the log road to Sportsman's Farm and continuing on it to an old quarry at top of hill.

Torrance Cave may be reached by following the road from Torrance toward the river.

The Loyalhanna was formerly quarried on Hillside Run (Ab 13, 14, 15) where it is about 60 feet thick. A conglomerate bed about three feet thick appears in the quarry wall near the top, but it was inaccessible for examination. Large abandoned quarries in the Loyalhanna are situated on Bridges Run (Ab 6) and south of Packsaddle (Ab 1, 5) where, at the latter place, the quarry face is 67 feet high. The Loyalhanna is imperfectly exposed on the railroad east of Torrance, but it is well exposed in an abandoned quarry on the north side of the Conemaugh River (Aa 53) where it is about 63 feet thick. Only the top of the Loyalhanna is exposed in the section along the railroad north of Bolivar, but the thickness is estimated to be 60 feet; it has the same thickness in a small quarry on the north side of the Conemaugh River (Bb 1).

The horizon of the Loyalhanna is well above drainage in the Blacklick gorge through Chestnut Ridge. Hillsides in the gorge are steep, boulder-strewn ones and weaker rocks are concealed. Platt (1877) reports 50 feet of Loyalhanna (Mountain limestone) in the gorge, but does not give any specific point of observation. The author was unable to find exposures to verify the presence of the Loyalhanna and as was explained previously, the base of the Connoquenessing sandstone appears so close to the top of the Pocono sandstone that very little room, if any, is available to allow for either the Mauch Chunk or the Loyalhanna. The rapid disappearance of the Upper Mississippian deposits from their fine development 5 miles to the south could be logically accounted for by a rapid and deep erosion. This conclusion is supported by the fact that Mauch Chunk red beds do not appear on the logs of wells drilled for natural gas in this area.

Pocono Group

Rocks of the Pocono group are exposed along the top and extend some distance downward on the slopes of Laurel Hill; the breadth of outcrop ranging from about 1¼ miles to nearly 3 miles. The Pocono forms an irregular pattern on Chestnut Ridge south of the Conemaugh River.

Because of the northeast plunge of the anticlinal axis these rocks are below the surface north of the river but reappear in the gorge of Blacklick Creek.

The Pocono is composed of greenish-gray, fine-grained sandstones and gray, coarse-grained to conglomeratic sandstones, with interbedded sandy shales. Muscovite mica flakes are common in the finer-grained sandstones, particularly on the bedding planes. The massive-bedded coarser-grained, conglomeratic sandstones are megascopically similar to those of the Pottsville series, and may easily be mistaken for them. Cross-bedding is prevalent in the thinner laminated beds.

A massive, medium-grained gray, quartzose sandstone at the top of the Pocono contains a persistent zone about 5 feet thick with scattered, rounded carbonate concretions up to one-half inch in diameter. This concreationary zone occurs from 10 to 20 feet below the base of the Loyalhanna limestone. The sand grains in this zone are well cemented and the outcrop is marked by weathered-out small boulders with conspicuous rounded pits on the surface where the carbonate concretions have been leached out (Figure 7). The position of this horizon with respect to the base of the Loyalhanna limestone is an invaluable key in mapping the geology on the boulder-strewn slopes of Laurel Hill and Chestnut Ridge, particularly where other recognizable horizons are concealed, which is not uncommon. An outcrop of this zone showing rounded

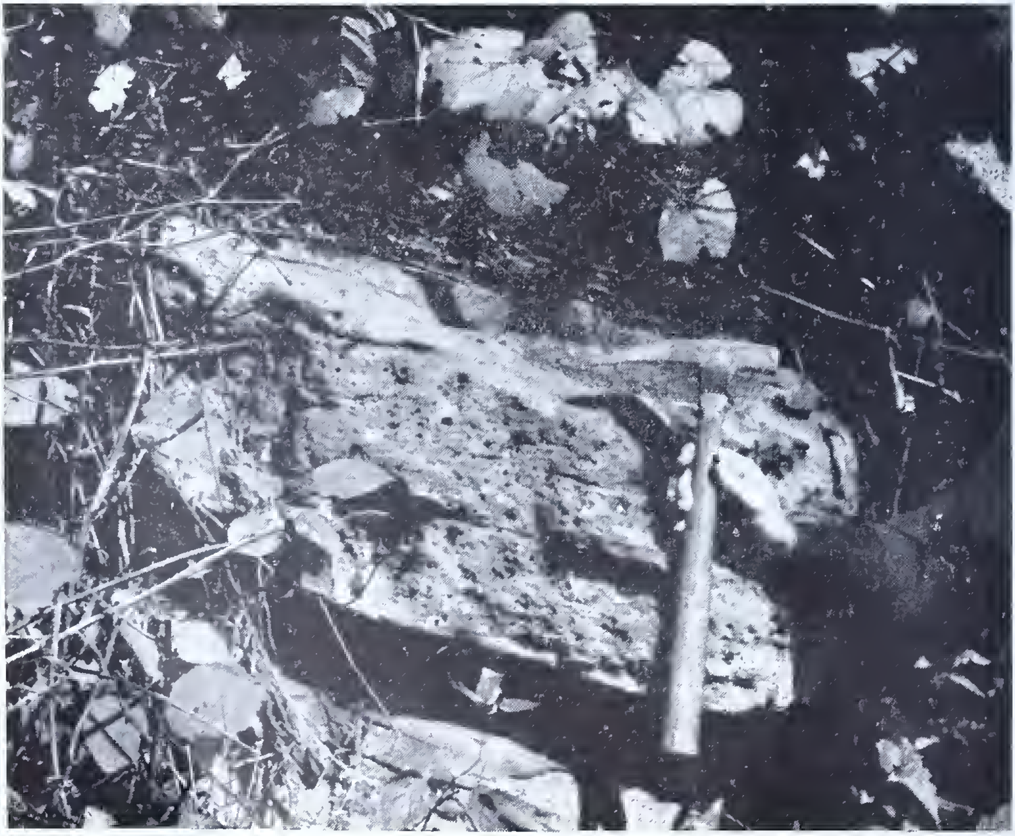


Figure 7. Pitted sandstone near top of Pocono, on Pa. Route 271 east side of Laurel Hill.

pits left by leached-out concretions is conveniently observable on the east side of Laurel Hill on Pa. Route 271 (Cc 8). A fresh exposure with the concretions in place is also conveniently displayed in the section southeast of Cramer in the Johnstown quadrangle.

The rocks composing the Pocono group are well displayed in the section along the Pennsylvania Railroad southeast of Torrance. The thickness of the group as determined by this author is approximately 550 feet. Bayles gives a thickness of 540 feet for the Pocono in his sample study of the Peoples Natural Gas Company's Camilla Griffen no. 3 well located 6 miles southwest of Torrance, in the Latrobe quadrangle (see section page 58). A sample study made by Fettke of the lower part of the Mississippian and the upper part of the Devonian in the Peoples Natural Gas Company's Camilla Griffen no. 1 well, located on Chestnut Ridge approximately 5½ miles south of the Conemaugh River (Ab 18), shows a thickness of a little over 738 feet of the Pocono (see section page 51). In the following descriptive section of the Pocono in the Torrance section, Fettke and Bayles (1944) give 652 feet for the thickness of the group.

Pocono section east of Torrance
(After Fettke and Bayles)

Thickness feet		*Cumulative thickness in feet*	
		Top	*Bottom*
11.0	Concealed	0.0	11.0
32.0	Sandstone, very fine-grained, light greenish gray, shaly, containing some muscovite	11.0	43.0
12.0	Sandstone, fine-grained, light greenish gray, massive, containing some muscovite	43.0	55.0
12.0	Shale, greenish gray, sandy	55.0	67.0
74.0	Sandstone, fine-grained, light greenish-gray, thick-bedded, containing some muscovite	67.0	141.0
25.0	Sandstone, medium-grained, light greenish-gray cross-bedded, containing some muscovite	141.0	166.0
8.0	Sandstone, very coarse-grained, light gray, containing sub-angular quartz pebbles up to one-half inch in diameter in lower 3 feet	166.0	174.0
5.5	Shale, greenish gray, sandy and silty	174.0	179.5
3.5	Sandstone, medium-grained, light greenish-gray massive	179.5	183.0
47.0	Sandstone, coarse-grained, light gray, containing some muscovite and occasional sub-angular to sub-rounded quartz pebbles up to one-fourth inch in diameter in upper part	183.0	230.0
50.0	Sandstone, fine-grained, greenish-gray, thick-bedded, containing some muscovite	230.0	280.0
47.0	Sandstone, fine-grained, greenish-gray, with some interbedded greenish-gray sandy shale	280.0	327.0
15.0	Shale, greenish-gray, sandy	327.0	342.0
13.0	Sandstone, very fine-grained, light greenish-gray	342.0	355.0
9.7	Sandstone, fine-grained, light gray, containing some muscovite	355.0	364.7
13.0	Sandstone, fine-grained, light greenish-gray, shaly, containing some muscovite	364.7	377.7
15.0	Shale, dark gray, with numerous interbedded thin seams of greenish-gray siltstone	377.7	392.7
60.0	Sandstone, fine-grained, light greenish-gray thick-bedded, containing some muscovite	392.7	452.7
24.0	Shale, greenish-gray, sandy	452.7	476.7
26.3	Conglomerate, flat pebble, gray	476.7	503.0
20.7	Concealed	503.0	523.7

Thickness feet		*Cumulative thickness in feet* *Top*	*Bottom*
2.0	Shale, gray, sandy	523.7	525.7
7.0	Sandstone, fine-grained, light gray, massive	525.7	532.7
29.0	Shale, gray, silty and sandy, with a great deal of interbedded fine-grained, light gray sandstone	532.7	561.7
	Measured on southeast limb of anticline 552.5 of Torrance section correlates with 315.0 of Bolivar section.		
68.0	Concealed	561.7	629.7
38.0	Sandstone, very fine-grained, light greenish-gray to greenish-gray, with numerous interbedded thin seams of greenish-gray, sandy shale	629.7	667.7
40.0	Sandstone, medium-grained in upper part, coarse to very coarse in lower part, light gray, with occasional thin pebble seams containing sub-rounded quartz pebbles up to 1¼ inches in diameter	667.7	707.7

Pocono section northwest of Bolivar
(After Fettke and Bayles)

Thickness feet		*Cumulative thickness in feet* *Top*	*Bottom*
265.0	Concealed; a fault cuts across section in this interval	0	265.0
6.5	Sandstone, very fine-grained, light greenish-gray, massive, containing some muscovite	265.0	271.5
18.5	Shale, greenish-gray, sandy, with considerable interbedded very fine-grained, light greenish gray sandstone	271.5	290.0
25.0	Sandstone, medium-coarse-grained, light gray, with numerous prominent interbedded flat pebble conglomerate lenses, containing quartz pebbles up to 1 inch in diameter	290.0	315.0
68.0	Concealed	315.0	383.0
38.0	Sandstone, very fine-grained, light greenish-gray to greenish gray, with numerous interbedded thin seams of greenish gray sandy-shale	383.0	421.0
40.0	Sandstone, medium-grained, in upper part, coarse to very coarse, in lower part, light gray, with occasional thin pebble seams containing subrounded quartz pebbles up to 1¼ inches in diameter	421.0	461.0

The Pocono is 808 feet thick where the rocks comprising the group are exposed on the west limb of Laurel Hill anticline southeast of Cramer in the Johnstown quadrangle. Following is the detailed section:

Pocono section southeast of Cramer
(After Fettke and Bayles)

Thickness feet		*Cumulative thickness in feet* *Top*	*Bottom*
135	Sandstone, fine-medium-grained, light greenish gray, massive, thick-bedded, containing some muscovite	0	135
7	Shale, greenish gray, sandy, containing some muscovite, with numerous thin seams and lenses of coal and some interbedded fine-grained sandstone	135	142

Thickness feet		Cumulative thickness in feet Top	Bottom
25	Shale, dark gray, and greenish gray, interbedded, silty, containing plant remains and a few thin coal lenses in upper part ..	142	167
34	Sandstone, fine-grained, light greenish gray, massive thick-bedded, containing a little muscovite	167	201
70	Sandstone, coarse to very coarse-grained, light gray to white, massive, containing sub-angular and subrounded quartz pebbles up to one-half inch in diameter	201	271
10	Sandstone, fine-medium-grained, light greenish gray, containing a little muscovite, with some interbedded dark greenish gray silty shale containing siderite concretions	271	281
18	Sandstone, fine-grained, light greenish gray, massive	281	299
19	Shale, greenish gray, silty, with a great deal of interbedded fine-grained, light greenish gray sandstone	299	318
46	Shale, greenish gray, silty, fissile, and greenish gray, siltstone, interbedded, exhibits spheroidal weathering	318	364
5	Sandstone, very fine-grained, light greenish gray, massive	364	369
49	Concealed	369	418
24	Shale, greenish gray, fissile, in part silty	418	442
18	Shale, greenish gray, silty and greenish gray siltstone, interbedded	442	460
11	Sandstone, very fine-grained, greenish gray, with some interbedded greenish gray sandy shale	460	471
95	Sandstone, very fine-grained, light greenish gray, thick-bedded, with a little interbedded greenish gray sandy shale; some muscovite present in both sandstone and shale	471	566
53	Sandstone, very fine-grained, greenish gray containing some muscovite, with considerable interbedded greenish gray sandy and micaceous shale	566	619
15	Conglomerate, fine to medium, light gray, containing many flat pebbles, some of which possess diameters of 2 inches	619	634
3	Sandstone, fine-grained, light greenish gray, thin-bedded, with some interbedded dark gray silty shale	634	637
14	Sandstone, medium to coarse-grained, light gray containing conglomeratic lenses and a few thin, dark gray shale seams	637	651
21	Sandstone, fine-medium-grained, light gray thin-bedded, with occasional interbedded conglomeratic lenses and some interbedded dark gray shale	651	672
9	Conglomerate, fine-cross-bedded, containing subrounded quartz pebbles up to one-fourth inch in diameter, with occasional interbedded dark gray shale seams	672	681
5	Sandstone, fine-medium-grained, light greenish gray, thin-bedded, with some interbedded conglomeratic lenses and some dark gray shale	681	686
34	Shale, very dark gray, almost black, fissile, with some thin seams of dark gray siltstone	686	720
17	Shale, dark gray to dark greenish gray, fissile silty, with interbedded thin seams of greenish gray siltstone	720	737
23	Sandstone, fine-grained, greenish gray, with a great deal of interbedded greenish gray sandy shale and dark gray shale	737	760
31	Sandstone, fine-medium-grained, light greenish gray, massive, with occasional thin conglomeratic seams. Pebbles, sub-rounded, consist mostly of milky quartz, with some chert and a few granitoid igneous rock pebbles also present. Sandstone in part crossbedded	760	791
17	Sandstone, medium-grained, light greenish gray, massive, with scattered quartz pebbles up to one-half inch in diameter and a few interbedded thin conglomeratic seams	791	808

A tentative correlation of the strata in the Mississippian series is included with the following discussion on the beds of Oswayo age in the Upper Devonian series.

DEVONIAN SYSTEM

Upper Devonian Series

Beds of Oswayo Age. The boundary between the base of the Pocono and the top of the Oswayo is marked where massive Pocono sandstone overlies alternating sandstones and shales, and siltstones containing faunal zones.

An inlier of beds of Oswayo age extends about 1.2 miles across the axis of the Chestnut Ridge anticline in the Conemaugh gorge, and about 180 feet of these rocks is above drainage where the axis of the anticline crosses the river. A little over 142 feet of the upper part is exposed on the south side of the river. Following is the section.

Section of upper part of Oswayo beds in Conemaugh gorge across Chestnut Ridge
(After Fettke and Bayles)

Thickness feet		*Cumulative thickness in feet*	
		Top	*Bottom*
37.0	Sandstone, very fine-grained, light gray, thin-bedded, with numerous interbedded thin seams of dark gray silty shale	0.0	37.0
90.0	Shale, greenish gray, sandy and silty, containing muscovite, with some interbedded thin seams of greenish gray siltstone, fossiliferous	37.0	127.0
9.2	Sandstone, very fine-grained, light greenish gray, thick-bedded ..	127.0	136.2
6.0	Sandstone, very fine-grained, light greenish gray, and greenish gray, interbedded, concealed	136.2	142.2

Bayles in his sample study of the Camilla Griffen no. 3 well, located about 6 miles south of Torrance in the Latrobe quadrangle logs a thickness of 227 feet of beds of Oswayo age. Details of the section are shown on page 58.

The following sections are sample study logs prepared by C. R. Fettke, showing the lower part of the Mississippian and upper part of the Devonian in the Camilla Griffen No. 1 (Ab 18) and No. 2 (Ab 19) wells. located on Chestnut Ridge anticline about 5½ miles south of Torrance.

Well-sample record of Camilla Griffen No. 1 Well
(After C. R. Fettke)

Thickness feet	Description of Strata	Depth in feet	
		Top	Bottom
	MISSISSIPPIAN SYSTEM		
	Pocono group, 738+ feet		
8	Soil	0 —	8
37	Sandstone, medium-grained, light gray, containing a little muscovite, stained yellowish-brown by weathering	8 —	45
11	Sandstone, fine to medium-grained, light gray, containing a little muscovite, in part stained yellowish-brown by weathering; *fresh water at 55 feet*	45 —	56
18	Sandstone, fine-grained, gray, containing some muscovite, stained yellowish and reddish-brown by weathering	56 —	74
9	Sandstone, fine to medium-grained, light gray, containing some muscovite, stained yellowish-brown by weathering; *fresh water at 75 feet*	74 —	83
	Bottom of weathered zone		83
7	Sandstone, fine to medium-grained, light gray, containing a little muscovite	83 —	90
15	Sandstone, medium-grained, gray, containing some muscovite and minute fragments of carbonized plant remains; a few quartz grains with diameters up to 2 millimeters present in lower part	90 —	105
15	Shale, dark gray, sandy, containing some muscovite and minute fragments of carbonized plant remains	105 —	120
11	Shale, dark gray, sandy, containing some muscovite and minute fragments of carbonized plant remains, with some interbedded very dark gray shale and a little coal	120 —	131
14	Sandstone, fine to medium-grained, gray, containing some muscovite and minute fragments of carbonized plant remains; minute clay ironstone pellets present in upper part	131 —	145
13	Sandstone, medium-grained, light gray, containing a little muscovite	145 —	158
53	Sandstone, medium to coarse-grained, light gray	158 —	211
16	Sandstone, fine to medium-grained, light gray, containing a little muscovite and a few minute fragments of carbonized plant remains	211 —	227
7	Sandstone, fine to medium-grained, light brownish-gray, with some interbedded gray silty shale	227 —	234
4	Sandstone, fine to medium-grained, light gray, with a great deal of interbedded dark greenish-gray shale	234 —	238
6	Shale, greenish-gray, with some interbedded dark gray shale	238 —	244
17	Shale, dark greenish gray, sandy, containing some muscovite and minute fragments of carbonized plant remains	244 —	261
13	Sandstone, very fine-grained, light gray, containing a little muscovite, with some interbedded gray silty shale	261 —	274
10	Sandstone, very fine-grained, light brownish-gray, containing a little muscovite, slightly calcareous	274 —	284
9	Sandstone, very fine-grained, brownish-gray, containing a little muscovite, with a little interbedded dark greenish-gray silty shale	284 —	293
9	Sandstone, very fine to fine-grained, light brownish-gray, containing a little muscovite and some minute fragments of carbonized plant remains and some minute clay ironstone pellets	293 —	302
19	Sandstone, very fine to fine-grained, light brownish-gray, containing a little muscovite with a little interbedded gray silty shale	302 —	321
12	Shale, dark gray, silty, with considerable interbedded very fine-grained, brownish-gray sandstone containing a little muscovite	321 —	333

Thickness feet	*Description of Strata*	*Depth in feet*	
		Top	*Bottom*
9	Sandstone, very fine grained, light brownish- and greenish-gray, containing some muscovite	333	342
10	Sandstone, very fine-grained, greenish-gray, containing some muscovite	342	352
4	Sandstone, very fine-grained, light greenish-gray, containing some biotite and muscovite, calcareous	352	356
20	Sandstone, very fine to fine-grained, brownish- and greenish-gray, containing some biotite and muscovite	356	376
11	Sandstone, very fine-grained, brownish and greenish-gray, containing some muscovite, with a little interbedded gray silty shale	376	387
4	Shale, dark greenish-gray, sandy, containing some muscovite	387	391
17	Sandstone, very fine-grained, greenish-gray, containing some muscovite, with a little interbedded gray silty shale	391	408
8	Sandstone, very fine to fine-grained, light greenish-gray, containing some muscovite and minute fragments of carbonized plant remains	408	416
7	Sandstone, very fine to fine-grained, light greenish-gray, containing some muscovite, with some interbedded dark gray silty shale	416	423
9	Sandstone, very fine to fine-grained, light brownish-gray, containing a little muscovite	423	432
11	Sandstone, fine-grained, light brownish-gray, containing a little muscovite, with a little interbedded dark gray silty shale	432	443
25	Shale, very dark gray, in part silty, with considerable interbedded very fine-grained, gray, argillaceous sandstone	443	468
24	Sandstone, very fine to fine-grained, light brownish and greenish-gray, containing a little muscovite	468	492
8	Shale, greenish gray, sandy, containing some muscovite and minute fragments of carbonized plant remains	492	500
8	Conglomerate, light gray, containing milky quartz pebbles up to 5 millimeters in diameter	500	508
21	Sandstone, very coarse-grained, conglomeratic, light gray, poorly sorted, containing quartz pebbles over 5 millimeters in diameter	508	529
8	Sandstone, fine-grained, light brownish-gray, with a few quartz grains up to 2 millimeters in diameter	529	537
13	Sandstone, very fine-grained, brownish-gray, containing a little muscovite	537	550
7	Shale, very dark gray, in part silty, with some interbedded very fine-grained, light gray sandstone	550	557
62	Shale. very dark gray, in part silty, with a little interbedded dark greenish-gray siltstone	557	619
10	Sandstone, very fine-grained, dark gray, argillaceous, with some interbedded very dark gray shale	619	629
9	Shale, very dark gray, sandy	629	638
5	Sandstone, very fine-grained, dark greenish-gray, with considerable interbedded very dark gray shale	638	643
22	Shale, very dark gray, in part silty, with some interbedded dark greenish gray siltstone	643	665
	Top of Murrysville sandstone	...	665
16	Sandstone, medium-grained, light gray	665	681
19	Sandstone, medium to coarse-grained, light gray, containing a few flat quartz pebbles up to 5 millimeters in diameter, with a little interbedded dark gray silty shale	681	700
26	Sandstone, medium to coarse-grained, light gray	700	726
8	Sandstone, very coarse-grained, conglomeratic, light gray	726	734
4	Sandstone, coarse-grained, light gray	734	738

Upper Devonian Series

Oswayo beds or equivalent, 231 feet

Thickness feet	Description of Strata	Depth in feet	
		Top	Bottom
13	Shale, very dark gray, silty, with a great deal of interbedded greenish-gray siltstone	738	751
6	Shale, dark greenish-gray, sandy	751	757
11	Shale, dark gray, with a great deal of interbedded greenish-gray siltstone	757	768
6	Sandstone, very fine-grained, light gray, with some interbedded dark gray shale	768	774
46	Shale, dark greenish gray, sandy, with a great deal of interbedded dark gray shale	774	820
45	Shale, dark gray, in part silty, with a little interbedded greenish-gray siltstone	820	865
10	Sandstone, very fine-grained, greenish-gray, containing some muscovite, with some interbedded gray to dark gray shale	865	875
7	Shale, greenish-gray, sandy	875	882
6	Siltstone, greenish-gray, with considerable interbedded dark gray shale	882	888
7	Shale, greenish-gray, sandy, with some interbedded dark gray shale	888	895
8	Sandstone, very fine-grained, light greenish-gray, containing a little muscovite, with a little interbedded dark gray shale	895	903
11	Shale, greenish-gray, sandy	903	914
23	Shale, dark gray, in part silty	914	937
23	Sandstone, very fine to fine-grained, light greenish-gray, containing a little muscovite and some minute fragments of carbonized plant remains	937	960
9	Sandstone, very fine-grained, greenish-gray, containing a little muscovite and some minute fragments of carbonized plant remains, with considerable interbedded dark gray shale	960	969
	Top of Catskill red beds	969	
16	Shale, dark brick red, silty, with some interbedded grayish-green silty shale	969	985
44	Shale, brick red, in part silty, with a little interbedded grayish-green shale	985	1029
29	Shale, gray to dark gray	1029	1058
26	Shale, greenish gray, sandy, containing some muscovite and minute fragments of carbonized plant remains	1058	1084
9	Shale, brick red, in part silty, with considerable interbedded dark gray shale and some greenish-gray silty shale	1084	1093
7	Shale, greenish-gray, silty, with some interbedded brick red silty shale	1093	1100

Well-sample record of Camilla Griffen No. 2 Well

MISSISSIPPIAN SYSTEM

Pocono group, 709+ feet

Thickness feet	Description of Strata	Top	Bottom
52	Sandstone, fine-grained, light gray, containing some muscovite and minute fragments of carbonized plant remains, in part stained yellowish-brown by weathering	0	52
7	Shale, dark gray, sandy, containing some muscovite and minute fragments of carbonized plant remains	52	59
12	Sandstone, medium-grained, light brownish-gray, containing a little muscovite and some minute fragments of carbonized plant remains	59	71
4	Shale, very dark gray, silty	71	75
18	Shale, dark gray, with a little interbedded black shale and coal	75	93

Thickness feet	*Description of Strata*	*Depth in feet*	
		Top	*Bottom*
5	Sandstone, fine-grained, light brownish-gray	93	98
18	Shale, grayish-black, silty	98	116
13	Sandstone, medium-grained, light gray	116	129
51	Sandstone, medium to coarse-grained, light gray	129	180
7	Sandstone, medium to coarse-grained, light gray, with considerable interbedded very dark gray silty shale	180	187
6	Sandstone, medium to coarse-grained, light gray, with a few light gray clay and yellowish-brown clay ironstone pellets	187	193
7	Shale, light greenish-gray, in part silty	193	200
22	Shale, gray, silty containing some muscovite and minute fragments of carbonized plant remains	200	222
10	Shale, gray, sandy, containing some muscovite and minute fragments of carbonized plant remains	222	232
18	Sandstone, very fine-grained, light greenish-gray, somewhat calcareous, containing a little muscovite and a few minute fragments of carbonized plant remains	232	250
57	Sandstone, fine-grained, light brownish-gray, containing some muscovite and minute fragments of carbonized plant remains	250	307
20	Shale, dark greenish-gray, sandy, containing some muscovite	307	327
23	Sandstone, very fine-grained, brownish-gray, containing a little muscovite and some minute fragments of carbonized plant remains	327	350
7	Sandstone, very fine-grained, brownish-gray, containing a little muscovite and some minute fragments of carbonized plant remains, with some interbedded dark gray silty shale	350	357
14	Sandstone, fine-grained, light brownish-gray, containing a little muscovite and some minute fragments of carbonized plant remains	357	371
6	Sandstone, fine-grained, light brownish-gray, containing a little muscovite and a few fragments of carbonized plant remains, with a little interbedded dark gray shale	371	377
18	Sandstone, fine-grained, brownish-gray, containing a little muscovite, a few minute fragments of carbonized plant remains and some yellowish-brown to dark brown clay ironstone pellets	377	395
13	Shale, dark gray, silty, with considerable interbedded greenish-gray siltstone	395	408
12	Shale, very dark gray, with some interbedded greenish-gray silty shale and siltstone	408	420
10	Sandstone, very fine to fine-grained, light greenish-gray, containing a little muscovite and some minute fragments of carbonized plant remains	420	430
19	Sandstone, fine-grained, brownish-gray, containing a little muscovite and some minute fragments of carbonized plant remains	430	449
6	Sandstone, fine-grained, light brownish-gray, containing a little muscovite and some minute fragments of carbonized remains, somewhat calcareous	449	455
15	Sandstone, very fine-grained, very dark brownish-gray, containing a little muscovite	455	470
10	Sandstone, coarse-grained, conglomeratic, light gray	470	480
20	Conglomerate, flat pebble, light gray	480	500
10	Shale, dark to very dark gray, silty, with a great deal of interbedded fine-grained, light gray, somewhat calcareous sandstone	500	510
8	Sandstone, very fine-grained, light brownish-gray, slightly calcareous	510	518
35	Shale, very dark gray, silty, with some interbedded gray siltstone	518	553

Thickness		*Depth in feet*	
feet	*Description of Strata*	*Top*	*Bottom*
12	Shale, grayish-black, with a little interbedded dark gray, slightly calcareous siltstone	553	565
15	Shale, grayish-black, with some interbedded very dark slightly calcareous, silty shale	565	580
5	Sandstone, very fine-grained, dark gray, with considerable interbedded dark gray silty shale	580	585
6	Shale, very dark gray, with considerable interbedded very fine-grained, gray sandstone	585	591
14	Siltstone, greenish-gray, with considerable interbedded dark gray silty shale	591	605
16	Sandstone, very fine to fine-grained, light gray, with a great deal of interbedded dark gray silty shale	605	621
12	Sandstone, very fine-grained, greenish-gray, containing a little muscovite and some minute fragments of carbonized plant remains, with some interbedded dark gray silty shale	621	633
	Top of Murrysville sandstone	633	
32	Sandstone, fine to medium-grained, light-gray, containing a few quartz grains up to 3 millimeters in diameter, with a little interbedded gray silty shale	633	665
8	Sandstone, medium to coarse-grained, light gray, almost white	665	673
5	Sandstone, coarse, conglomeratic, light gray, almost white	673	678
15	Sandstone, medium to coarse-grained, light gray, almost white, with a little interbedded gray sandy shale	678	693
7	Sandstone, coarse-grained, conglomeratic, light gray, almost white	693	700
4	Sandstone, fine-grained, light gray	700	704
5	Sandstone, coarse-grained, light gray, almost white	704	709

Upper Devonian series

Oswayo beds or equivalent, 228 feet

26	Sandstone, very fine-grained, light brownish-gray, containing a little muscovite	709	735
10	Sandstone, very fine-grained, light brownish-gray, slightly calcareous, with a little interbedded gray shale	735	745
32	Sandstone, very fine-grained, dark brownish-gray, containing some muscovite, with some interbedded dark gray shale in lower part	745	777
3	Shale, dark gray	777	780
28	Siltstone, greenish-gray, with considerable interbedded gray shale	780	808
21	Shale, dark gray, with some interbedded greenish silty shale and siltstone	808	829
36	Siltstone, greenish-gray, containing occasional shell fragments, with considerable interbedded gray to dark gray shale	829	865
9	Shale, dark gray, silty, with considerable interbedded greenish-gray siltstone containing occasional shell fragments	865	874
10	Shale, gray, with considerable interbedded greenish-gray silty shale containing minute fragments of carbonized plant remains	874	884
14	Sandstone, very fine-grained, light greenish-gray, containing some muscovite, with some interbedded dark gray shale	884	898
33	Sandstone, very fine-grained, light greenish-gray, containing some muscovite and minute fragments of carbonized plant remains, with a little interbedded gray to dark gray shale	898	931
6	Shale, greenish-gray, silty, containing some muscovite	931	937
	Top of Catskill red beds	937	
14	Shale, brick red, in part silty, with a little interbedded greenish-gray silty shale	937	951

A complete section of Oswayo rocks, 237 feet thick, is excellently exposed in the Cramer section on the west limb of Laurel Hill anticline in the Johnstown quadrangle. There the base of a medium-grained, light greenish-gray, massive, pebby Pocono sandstone is in contact with 1 foot of light gray clay and fossiliferous limestone of Oswayo age. Grayish-green shale at the base of the Oswayo lies on silty Catskill red shale. These beds consist essentially of greenish-gray, fine-grained sandstones, siltstones and shales, with about 2 feet of alternating thin layers of shale and limestone at the top, and some fossil zones in the upper part. The detailed section is as follows:

Upper Devonian series in section southeast of Cramer. Beds of Oswayo age, 237 feet (After Fettke and Bayles)

Thickness		*Cumulative thickness in feet*	
feet		*Top*	*Bottom*
0.7	Clay, light gray	0.0	0.7
0.3	Limestone, dark gray, sandy, ferruginous and fossiliferous	0.7	1.0
0.2	Shale, dark gray, calcareous and fossiliferous	1.0	1.2
0.7	Limestone, like above	1.2	1.9
0.7	Shale, dark gray, calcareous	1.9	2.6
0.4	Limestone, like above	2.6	3.0
27.0	Shale, dark gray, with considerable interbedded greenish gray silty shale and siltstone, containing fossils mostly brachiopods	3.0	30.0
48.0	Siltstone, greenish gray, calcareous and light greenish gray shale, interbedded	30.0	78.0
19.0	Shale, gray, with a considerable number of interbedded thin seams of greenish gray siltstone containing fossils, mostly brachiopods	78.0	97.0
11.0	Sandstone, fine-grained, light greenish gray, thin-bedded, thin seams of greenish gray silty shale	97.0	108.0
28.0	Shale, gray, with some interbedded greenish gray silty shale and siltstone containing fossils	108.0	136.0
7.0	Sandstone, very fine-grained, greenish gray, thin-bedded, with some interbedded thin seams of greenish gray shale	136.0	143.0
4.0	Shale, greenish gray, silty fissile	143.0	147.0
7.0	Shale, greenish gray, silty and thin seams of greenish gray siltstone containing fossils, interbedded	147.0	154.0
39.0	Sandstone, very fine-grained, light greenish gray, massive, containing muscovite	154.0	193.0
21.0	Sandstone, very fine-grained, greenish gray thin-bedded, with some interbedded greenish gray shale	193.0	214.0
13.0	Sandstone, very fine-grained, light greenish gray containing muscovite	214.0	227.0
7.0	Shale, greenish gray, silty	227.0	234.0
3.0	Shale, grayish green	234.0	237.0
	Top of Catskill red beds		
44.0	Shale, red, in part silty	237.0	281.0
22.0	Sandstone, very fine-grained, greenish gray, with some interbedded red and grayish green shale	281.0	303.0
11.0	Siltstone, greenish gray, containing some muscovite	303.0	314.0
51.0	Shale, dark reddish gray, fissile, with a few thin seams and lenses of greenish gray, very fine-grained sandstone	314.0	365.0

Thickness feet		Cumulative thickness in feet Top	Bottom
13.0	Sandstone, very fine-grained, greenish gray, thin bedded, with considerable interbedded dark reddish gray shale	365.0	378.0
4.0	Sandstone, very fine-grained, greenish gray, massive and lenticular	378.0	382.0
12.0	Shale, light greenish gray, fissile	382.0	394.0
20.0	Shale, dark purplish red	394.0	414.0
	Concealed		

SUBSURFACE STRATIGRAPHY

Upper, Middle and Lower Devonian Series

Information about the unexposed rocks or subsurface stratigraphy of the New Florence quadrangle is based on two deep exploratory wells drilled for natural gas, which were logged from sample studies and the sections are presented in the tabular form (page 58). Subsurface section no. 1 is the sample log of the Peoples Natural Gas Company Griffen no. 3 well. The sample study was made by R. E. Bayles, geologist for that company. The well is located in the Latrobe quadrangle about 1 mile west of the Camilla Griffen No. 1 well (Ab 18). Subsurface section no. 2 is a sample log of the New Penn Development Corp., Indiana Savings Bank well, which was started by Altmont Development Company and known as the Kern-Dodge well. The sample study was made by Fred Whiteside of unknown affiliation. The well is located on the crest of Laurel Hill in the southeastern part of the quadrangle (Cc. 10).

The Camilla Griffen no. 3 well started in the Burgoon sandstone of the Pocono, penetrated the rocks of the Devonian system (7,134 feet), and was completed 500 feet below the top of the Upper Silurian system, to a total depth of 8,174 feet. The Devonian system is divided into upper, middle and lower series. The Upper Devonian, 5,847 feet thick, contains the oil and "shallow" gas sands of western Pennsylvania. The series is subdivided into the Oswayo at the top, the Catskill red beds, the Chemung and Portage shales and sandstones with the Tully limestone member at the base. The Middle Devonian, 843 feet thick, is composed of the Hamilton group and the Onondaga formation; the Oriskany "deep gas sand" and the Helderberg group make up the Lower Devonian series, 444 feet thick. Subdivisions of the Upper Silurian system consists of the Keyser limestone at the top, the Tonoloway limestone, Wills Creek shales and the Bloomsburg red shales and sandstones.

The major divisions of the Devonian and Silurian systems have been further subdivided where these strata crop out and have been studied in great detail east of the Allegheny topographic front (Willard, Swartz and Cleaves 1939). Devonian and Silurian rocks are well exposed in the cuts along the Pennsylvania Turnpike from Bedford westward to Allegheny tunnel (Cleaves and Stevenson 1949). Details of the major divisions of the Devonian system and the Upper Silurian series have not been worked out in the sample study of Camilla Griffen no. 3 well, because of uncertainty of long range correlation. Also, that detailed break-down is, to some extent, based on paleontological evidence, which in well cuttings is too fragmental for certain identity.

Generally, the Oswayo, 227 feet thick, consists of fine-grained sandstones, siltstones and shales; the Catskill red beds, 399 feet thick, consists of alternating red and gray sandstones, siltstones and shales; the Chemung and Portage, 5167 feet thick, are a monotonous sequence of sandstones, siltstones, and shales, with numerous fossil horizons. The Tully limestone, 54 feet thick, is composed of light gray limestone and dark gray calcareous shale. It is an easily recognized and important marker in deep well drilling. The Hamilton group, 653 feet thick, is dominantly gray to black shales, with relatively minor interbedded limestone; the Onondaga formation, 190 feet thick, consists of dark shale and limestone in the upper part, and chert in the lower part. The Oriskany, 60 feet thick, is cherty in the top few feet; the rest of the member being calcareous sandstones and sandy limestones; and Helderberg group, 384 feet thick, is mainly silty limestone, with an upper fossiliferous zone and a cherty lower part.

The Devonian-Silurian contact in the sample log is drawn at the base of a gray, cherty limestone and the top of a brownish gray, coarsely crystalline limestone. The 500 feet of Upper Silurian penetrated consists of 288 feet of gray to brown limestones, some of which are pyritic and dolomitic; and 212 feet of gray to brown limestones containing variable amounts of anhydrite. In the section on the Pennsylvania Turnpike, the Keyser limestone at the top of the Silurian is blue-gray and 250 feet thick, and it overlys the bluish gray, thin-bedded to shaly Tonoloway limestone which is 700 feet thick.

The Indiana Savings Bank well (Subsurface section no. 2) started at about the middle of the Pocono and was completed in the top of the Oriskany "sand" at a total depth of 7,724 feet. The Pocono-Oswayo contact is uncertain, but if tentatively placed at the base of a conglomerate at a depth of 408 feet, and assuming that the top of the Catskill is the top of the first red bed at depth of 758 feet, the thickness of the Oswayo would therefore be 350 feet. Also, if the base of a 45 foot thick sandy limestone lying at a depth of 6,447 feet be taken for the base of the Tully limestone, the thickness of the Upper Devonian series would be 6,039 feet with the Catskill red beds 441 feet thick, and the Chemung and Portage shales and sandstones, 5,203 feet thick. The Middle Devonian with the Hamilton group 1,141 feet thick, and the Onondaga formation 144 feet thick, is 1,285 feet thick.

Subsurface section no. 1

Sample log of Peoples Natural Gas Company Camilla Griffen no. 3 well

(Sample study log by R. E. Bayles)

Thickness feet	*Description of Strata*	*Cumulative thickness in feet* *Top*	*Bottom*
	Mississippian System Pocono sandstone 540 feet Burgoon (Big Injun Sand) 0-78		
40	Sandstone; weathered brown, medium to coarse, free and clustered	0 —	40
38	Sandstone; gray, very fine. (Water @ 70′)	40 —	78
13	No samples	78 —	91

Squaw Sands 91-316

Thickness feet		*Cumulative thickness in feet*	
		Top	*Bottom*
20	Sandstone; light chocolate, fine, micaceous	91	111
26	Sandstone; gray with a chocolate cast, very fine micaceous	111	137
7	Siltstone; green with a few chocolate fragments	137	144
15	Sandstone; white, fine, free grained	144	159
30	No samples. (Water @ 162′)	159	189
28	Sandstone; light gray with a chocolate cast, very fine, calcareous	189	217
6	Siltstone; green, coarse, calcareous, with 50% above chocolate sandstone	217	223
5	Sandstone; light gray, very fine containing carbonized plant fossils	223	228
9	Siltstone; gray, very fine	228	237
16	Sandstone; gray, very fine	237	253
14	Shale; gray, silty	253	267
35	Sandstone; greenish gray with a slight chocolate cast, very fine, free and clustered	267	302
14	Sandstone; white, coarse, conglomeratic. (Pebbles ¼″ or more in diameter.)	302	316
21	Siltstone; gray, coarse	316	337
11	Sandstone; light gray, white, very fine	337	348
15	Shale; dark gray, silty	348	363
43	Shale; dark gray, pyritic	363	406
6	Shale, gray	406	412

Second Gas Sand 412-437

5	Sandstone; gray, very fine with 50% above shale	412	417
20	Sandstone; gray, very fine	417	437
7	Shale; gray with interbedded siltstone	437	444

Murraysville Sand 444-450

15	No samples. (Use 444 as top of sandstone described below.)	444	459
4	Sandstone; white, fine, free grained	459	463
23	Sandstone; white, fine to medium, free grained	463	486
16	Sandstone; white, medium to coarse, free grained	486	502
13	Sandstone; as above—rusty	502	515
25	Sandstone; white, medium to coarse, free grained. Many grains well rounded. Conglomeratic toward base. Calcareous in upper half	515	540

Devonian System 7134 feet

Upper Devonian series 5847 feet

Oswayo 227 feet

2	Siltstone; gray, very coarse grading into a very fine sandstone	540	542

Hundred Foot Sand 542-645

9	Sandstone; light chocolate, fine	542	551
2	Sandstone; light chocolate through gray to greenish gray, very fine	551	553
5	Sandstone; as above with a little interbedded gray shale	553	558
7	Sandstone; light gray (with a chocolate cast), fine	558	565
16	Sandstone; gray, very fine, pyritic	565	581
18	Shale; gray with interbedded greenish gray siltstone	581	599
5	Sandstone; light brown to greenish gray, very fine	599	604

Thickness feet	Description of Strata	Cumulative thickness in feet	
		Top	Bottom
5	Shale; gray	604	609
13	Sandstone; greenish gray to gray, very fine with a little interbedded gray shale	609	622
16	Sandstone; as above with interbedded shale and siltstone, all are calcareous	622	638
7	Sandstone; light greenish gray, very fine, pebbly	638	645
9	Siltstone; greenish gray with a few medium sand grains	645	654
22	Shale with interbedded siltstone; gray to greenish gray	654	676
	Thirty Foot Sand 676-690		
14	Sandstone; brownish gray, very fine, micaceous	676	690
5	Shale; gray	690	695
20	Shale; gray with interbedded siltstone	695	715
	Snee Sand 715-757		
24	Sandstone; light gray, very fine with a little gray shale in top	715	739
18	Sandstone; light gray, very fine with carbonized plant fossils. Some interbedded gray shale increasing in amount downward. Sandstone is calcareous and fossiliferous at base	739	757
10	Shale; gray	757	767
	Catskill 399		
10	Shale; red, silty	767	777
23	Shale; gray, argillaceous with a little interbedded siltstone	777	800
11	Shale; red, greenish gray and gray	800	811
36	Shale; gray	811	847
20	Shale; gray to greenish gray, silty. Contains a few siderite pellets	847	867
	Gordon Stray Sand 867-904		
9	Sandstone; gray, very fine and silty, micaceous	867	876
11	Siltstone; gray	876	887
17	Sandstone; dark brownish gray, very fine, micaceous	887	904
7	Shale; greenish gray	904	911
18	Shale; red, silty	911	929
31	Shale; light gray with interbedded siltstone	929	960
28	Shale; red gray and greenish gray	960	988
19	Shale with interbedded siltstone; light gray	988	1007
31	Shale; red	1007	1038
29	Shale; red, silty	1038	1067
16	Shale with a little interbedded siltstone; light gray	1067	1083
	Fourth Sand 1083-1091		
8	Sandstone; light gray, very fine, micaceous with 50% above shale and siltstone	1083	1091
10	Shale; gray, silty	1091	1101
10	Shale; red	1101	1111
10	Shale; gray to dark gray	1111	1121
35	Shale; red	1121	1156
10	Shale with interbedded siltstone; gray and red	1156	1166

Chemung and Portage 5176 feet
Fifth Sand 1166-1204

Thickness feet	Description of Strata	Cumulative thickness in feet		
		Top		Bottom
16	Sandstone; variegated, very fine shaly	1166	—	1182
14	Sandstone; variegated, fine, free and clustered	1182	—	1196
8	Sandstone; light gray and chocolate, fine, free and clustered	1196	—	1204
33	Shale; greenish gray with a little interbedded siltstone	1204	—	1237
	Bayard Stray Sand 1237-1269			
15	Shale; gray with 20% gray and light chocolate, fine grained sandstone	1237	—	1252
17	As above; sandstone increases to 50%	1252	—	1269
25	Shale; gray with interbedded greenish gray siltstone	1269	—	1294
9	Shale; gray	1294	—	1303
6	Siltstone; greenish gray, micaceous with 35% gray shale	1303	—	1309
69	Shale; gray with a little interbedded greenish gray siltstone	1309	—	1378
22	As above; siltstone is slightly fossiliferous	1378	—	1400
14	Siltstone; greenish gray, fossiliferous with interbedded gray shale	1400	—	1414
41	Shale; gray with a little interbedded siltstone. Siltstone is occasionally fossiliferous	1414	—	1455
30	Siltstone; chocolate gray to greenish gray, fossiliferous with 40% gray shale	1455	—	1485
13	Siltstone; light gray, fossiliferous	1485	—	1498
3	Sandstone; light gray, very fine, fossiliferous	1498	—	1501
39	Shale; gray with 20-40% interbedded greenish gray siltstone	1501	—	1540
38	Shale; gray with interbedded gray siltstone	1540	—	1578
8	As above with 5% dark gray, very fine sandstone containing coarser sand grains	1578	—	1586
27	As above. Some of the sandstone fragments have a greenish cast and contain minute flecks of hematite (Red Warren?)	1586	—	1613
27	Shale; gray with interbedded light gray sandy siltstone	1613	—	1640
17	Sandstone; light gray with a chocolate cast, fine grained, pebbly with an equal amount of green, very fine sandstone. Shale and siltstone make up 50% of sample	1640	—	1657
8	Shale; gray with interbedded greenish gray sandy siltstone	1657	—	1665
8	Shale; gray	1665	—	1673
60	Shale; gray with interbedded greenish gray sandy siltstone. Siltstone contains occasional medium sand grains	1673	—	1733
30	Shale; gray with interbedded gray siltstone	1733	—	1763
8	Sandstone; light chocolate gray to greenish gray, very fine with many medium sand grains	1763	—	1771
7	Sandstone; chocolate, very fine	1771	—	1778
14	Shale; dark gray	1778	—	1792
11	Shale; gray to dark gray with 35% light chocolate to greenish gray, very fine sandstone	1792	—	1803
46	Shale; gray with interbedded greenish gray siltstone	1803	—	1849
	Speechley Sand 1849-1934			
5	Sandstone; white, very fine	1849	—	1854
6	Shale; red and green with a few embedded fine sand grains	1854	—	1860
5	Shale; red and green with 35% variegated, very fine sandstone	1860	—	1865
26	Sandstone; light greenish gray, very fine with a little interbedded gray shale	1865	—	1891
35	Sandstone; light chocolate, fine to very fine	1891	—	1926
8	Sandstone; light chocolate, fine to medium, free and clustered	1926	—	1934
14	Shale; very dark gray with a little gray shale	1934	—	1948
24	Shale; gray with a little dark gray shale	1948	—	1972

Tiona Sand 1972-2031

Thickness feet	*Description of Strata*	*Cumulative thickness in feet*	
		Top	*Bottom*
6	Sandstone; green, very fine, pebbly	1972	1978
10	Sandstone; light gray to green, very fine, pyritic. Contains carbonized plant fossils	1978	1988
7	Shale; gray to dark gray with a little above sandstone	1988	1995
36	Sandstone; light gray to white, fine. Conglomeratic at top. Some fragments have a chocolate cast	1995	2031
74	Shale; gray, argillaceous	2031	2105
18	Shale; gray, with 10-20% gray, very fine sandstone	2105	2123

Balltown Sand 2123-2176

Thickness feet	*Description of Strata*	*Cumulative thickness in feet*	
		Top	*Bottom*
20	Sandstone; gray, fine, dolomitic	2123	2143
7	Sandstone; gray, fine fossiliferous with considerable interbedded gray shale	2143	2150
26	Shale; gray with 20-30% gray, very fine sandstone	2150	2176
40	Shale; gray	2176	2216
39	Shale; gray with a little interbedded gray fine shaly sandstone	2216	2255
5	Sandstone; light gray, very fine with 50% gray shale	2255	2260
6	Shale; gray with 10-20% gray, very fine, pebbly sandstone	2260	2266
25	Shale; dark gray	2266	2291
14	Sandstone; chocolate, very fine	2291	2305
14	Shale; gray with a little above sandstone in top	2305	2319
13	Shale; gray, sandy	2319	2332
12	Sandstone: light gray, very fine fossiliferous with 50% gray shale	2332	2344
24	Shale; gray with a little above sandstone	2344	2368
7	Shale; gray	2368	2375
10	Shale; gray with interbedded greenish gray siltstone	2375	2385
35	Siltstone; light gray	2385	2420
14	Shale; gray with interbedded siltstone	2420	2434

Second Bradford Sand 2434-2452

Thickness feet	*Description of Strata*	*Cumulative thickness in feet*	
		Top	*Bottom*
18	Sandstone; very light chocolate, fine. Occasional pebble	2434	2452
20	Shale; gray with interbedded greenish gray siltstone	2452	2472
32	Sandstone; light gray and chocolate, very fine, pebbly in top with 50% gray shale	2472	2504
7	Shale; gray	2504	2511

Third Bradford Sand 2511-2529

Thickness feet	*Description of Strata*	*Cumulative thickness in feet*	
		Top	*Bottom*
7	Sandstone; light gray with a chocolate cast, fine, pebbly	2511	2518
11	Sandstone; chocolate, fine to medium, pebbly	2518	2529
30	Siltstone; gray	2529	2559
15	Shale; gray	2559	2574
6	Sandstone; rusty, fine to coarse, free and clustered with 50% gray shale	2574	2580
14	Sandstone; light gray, very fine with interbedded gray shale. (Gas—Pocket @ 2582′)	2580	2594
31	Shale; gray	2594	2625
8	Shale; gray with interbedded greenish gray siltstone	2625	2633
14	Shale; gray with a little interbedded light gray sandy siltstone	2633	2647
18	Shale; gray with 10-30% chocolate, very fine sandstone	2647	2665
29	Shale; gray with a little light greenish gray fossiliferous siltstone and above sandstone	2665	2694
19	Shale; gray	2694	2713

Kane Sand 2713-2736

Thickness feet	Description of Strata	Cumulative thickness in feet		
		Top		Bottom
23	Sandstone; chocolate, very fine	2713	—	2736
24	Shale; gray with interbedded light gray siltstone. Also 10-20% above sandstone	2736	—	2760
52	Siltstone; light greenish gray, fossiliferous	2760	—	2812
18	Siltstone; as above with 10-20% chocolate, very fine, silty sandstone	2812	—	2830
70	Siltstone; light greenish gray, fossiliferous with a little interbedded gray shale	2830	—	2900
33	Siltstone; light greenish gray	2900	—	2933
21	Siltstone; light gray, coarse, with a few fragments of chocolate, very fine sandstone	2933	—	2954
34	Siltstone: light greenish gray with a little interbedded gray shale	2954	—	2988
67	Shale; gray with interbedded greenish gray siltstone	2988	—	3055
50	Shale; gray with interbedded light gray siltstone	3055	—	3105
27	Siltstone; light gray with a little interbedded gray shale. Fossiliferous in top	3105	—	3132
58	Shale; gray, silty. Occasionally fossiliferous in more silty beds	3132	—	3190
42	Siltstone; gray, fossiliferous	3190	—	3232
31	Shale, gray	3232	—	3263
57	Siltstone; gray with interbedded gray shale	3263	—	3320
21	As above; fossiliferous	3320	—	3341
24	Siltstone; gray with interbedded gray shale. Shale is a little darker gray than any above (below 3rd Bradford)	3341	—	3365
45	Siltstone; light gray to gray, coarse, fossiliferous with interbedded gray shale	3365	—	3410
64	Shale; gray with a little interbedded siltstone	3410	—	3474
41	Shale; gray to dark gray	3474	—	3515
35	Shale; gray to dark gray (darker than above)	3515	—	3550
14	Siltstone; light gray with interbedded gray shale	3550	—	3564
38	Siltstone; light gray, coarse	3564	—	3602
22	Siltstone; light gray, fossiliferous	3602	—	3624
10	Siltstone; gray, fossiliferous with interbedded gray shale	3624	—	3634
43	Siltstone; gray with interbedded gray shale. Occasionally fossiliferous	3634	—	3677
17	Sandstone; white, very fine with 50% gray shale	3677	—	3694
13	Siltstone; gray, fossiliferous with interbedded gray shale	3694	—	3707
31	Shale; gray	3707	—	3738
8	Siltstone; light gray, fossiliferous with a little interbedded gray shale	3738	—	3746
46	Shale; gray with interbedded siltstone	3746	—	3792
28	Shale; gray	3792	—	3820
12	Siltstone; light gray	3820	—	3832
10	Shale; gray with interbedded siltstone	3832	—	3842
21	Shale; gray	3842	—	3863
57	Shale; gray with a little interbedded siltstone	3863	—	3920
21	Shale; gray	3920	—	3941
59	Shale; gray with a little interbedded siltstone	3941	—	4000
55	Shale; gray with interbedded siltstone. Occasionally fossiliferous	4000	—	4055
7	As above with a little light gray, very fine, fossiliferous sandstone	4055	—	4062
81	Shale; gray with interbedded siltstone. Occasionally fossiliferous	4062	—	4143
40	Siltstone; dark chocolate gray with 50% gray shale	4143	—	4183
27	Shale; gray with interbedded gray to chocolate siltstone	4183	—	4210
160	Shale; gray with a little interbedded gray siltstone	4210	—	4370

Thickness feet		Cumulative thickness in feet Top		Bottom
34	Siltstone; gray, very fine with a little interbedded shale	4370	—	4404
70	Shale; gray with interbedded siltstone	4404	—	4474
196	Shale; gray. Slightly darker than above	4474	—	4670
25	Shale; gray with interbedded siltstone	4670	—	4695
123	Shale; gray with a little interbedded gray siltstone	4695	—	4818
83	Shale; gray with interbedded siltstone	4818	—	4901
74	Shale; gray to dark gray with interbedded gray siltstone	4901	—	4975
215	Shale; gray with interbedded siltstone	4975	—	5190
41	Shale; gray with interbedded siltstone. Also a little dark gray to black silty shale	5190	—	5231
34	Shale; gray with interbedded siltstone	5231	—	5265
38	Shale; gray to dark gray with interbedded siltstone	5265	—	5303
31	Shale; gray	5303	—	5334
258	Shale; gray with a little interbedded light gray siltstone	5334	—	5592
106	Shale; gray to dark gray	5592	—	5698
187	Shale; gray, silty	5698	—	5885
87	Shale; gray with 5-10% interbedded dark gray silty shale	5885	—	5972
30	Shale; gray (slightly darker than above) with a little interbedded dark gray shale	5972	—	6002
33	Shale; gray to dark gray	6002	—	6035
61	Shale; gray with a little interbedded dark gray shale	6035	—	6096
146	Shale; dark gray to black	6096	—	6242
13	Shale; dark gray to black with 10-15% gray, silty limestone	6242	—	6255
78	Shale; black, pyritic. Slightly calcareous	6255	—	6333

4th Tully limestone 6333-6387

42	Limestone; light gray, slightly pyritic. (Black shale makes up 50% or more of samples. Probably caving from above)	6333	—	6375
12	Shale; dark gray. Calcareous	6375	—	6387

Middle Devonian Series 843 feet
Hamilton group 6387-7040

22	Shale; gray to dark gray	6387	—	6409
218	Shale; gray, pyritic	6409	—	6627
50	Shale; dark gray, pyritic	6627	—	6577
133	Shale; dark gray	6677	—	6810
40	Shale; dark gray to black, pyritic	6810	—	6850
45	Shale; dark gray to black—mostly black. Pyritic. Occasional thin beds of dark brownish gray, pyritic, impure limestone	6850	—	6895
85	Shale; black, pyritic. Contains occasional thin beds of dark brownish gray, pyritic impure limestone. (Gas-Pockets @ 6978′, 6980′)	6895	—	6980
44	Shale; black, pyritic. Limestone beds described above are more common. Fragments of limestone usually make up 5-10% of sample. (Gas—Pockets @ 6984′, 6992′, 6995′, 6996′, 7000′, 7003′, 7014′)	6980	—	7024
4	Shale; black, pyritic with 10-15% dark gray to black limestone. Limestone has a quite different appearance from that described above. It is more pure and contains no pyrite. Some fragments have a conchoidal fracture. (Gas—Pockets @ 7024′, 7029′)	7024	—	7028
12	Shale; black pyritic, containing a few fragments of limestone like above	7028	—	7040

Onondaga formation 7040-7230

Thickness feet	*Description of Strata*	*Cumulative thickness in feet*	
		Top	*Bottom*
6	Shale; black, pyritic with 25% black, impure limestone. Also 25-30% brown micaceous, pyritic shale ("Brown break")	7040	7046
11	Limestone; dark gray to black, with 50% brown shale. Also a large amount of black shale which is probably caving	7046	7057
15	Limestone; like above with a great deal of black shale cavings	7057	7072
2	As above with 10-15% light gray to milky chert. Top of chert @ 7073′	7072	7074
10	Chert; light gray, translucent and opaque. Slightly calcareous	7074	7084
26	Chert; brown and light gray. Brown chert is opaque and silty. Slightly calcareous in top 5′	7084	7110
8	Chert; brown, silty	7110	7118
1	Chert; brown and light gray, silty. Light gray chert contains glauconite	7118	7119
3	Chert; light gray, silty	7119	7122
7	Chert; brown and light gray, silty	7122	7129
8	Chert; brownish gray and gray, silty	7129	7137
10	Chert; light gray, translucent and opaque	7137	7147
4	Chert; gray to light gray. Mostly opaque	7147	7151
6	Chert; gray to light gray, silty	7151	7157
8	Chert; gray, shaly	7157	7165
11	Chert; gray to light gray. Opaque and translucent	7165	7176
7	Chert; gray	7176	7183
43	Chert; darker gray, shaly. Becomes more shaly downward	7183	7226
3	Chert; dark gray, shaly	7226	7229

Lower Devonian Series 444 feet

Oriskany Sandstone 7230-7290

3	Chert; as above with 20% gray, fine grained, pyritic sandstone. Top of Oriskany @ 7230½′	7229	7232
14	Sandstone; gray, fine to medium with a few coarse sand grains. Very calcareous. Pyritic at top	7232	7246
4	Sandstone; gray, very fine, highly calcareous with 25-30% dark gray, pyritic shale	7246	7250
3	Limestone; gray, sandy. Sand grains range from a silt to fine in size	7250	7253
5	Limestone; as above with 50% dark gray, pyritic calcareous shale	7253	7258
3	Limestone; gray, silty containing many sand grains ranging in size from very fine to coarse	7258	7261
3	Sandstone; gray, fine to medium with a few coarse grains. Highly calcareous	7261	7264
22	Limestone; gray, sandy. Sand grains are mostly very fine	7264	7286
4	Limestone; gray, sandy. Sand grains range from very fine to coarse	7286	7290

Helderberg Limestones 7290-7674

81	Limestone; light gray, very silty. Well defined sand grains no longer present. Also an occasional fragment of bluish translucent chert. Fossiliferous	7290	7371
33	Limestone; light gray, silty	7371	7404
37	Limestone; gray, silty	7404	7441
216	Limestone; dark gray to black; shaly. Grades downward into a highly calcareous shale	7441	7657
9	Chert; light gray to milky, highly calcareous	7657	7666
8	Limestone; gray, cherty	7666	7674

Silurian System 500 feet +

Thickness feet	Description of Strata	Cumulative thickness in feet	
		Top	Bottom
19	Limestone; brownish gray, coarsely crystalline	7674 —	7693
10	Limestone; dark brownish gray	7693 —	7703
25	Limestone; brown. Breaks in small chips	7703 —	7728
6	Limestone; brown with 10-20% light gray, dolomitic limestone	7728 —	7734
5	Limestone; brown	7734 —	7739
4	Limestone; brown with 10-20% light gray, dolomitic limestone	7739 —	7743
6	Limestone; brown	7743 —	7749
12	Limestone; dark gray and brownish gray with 50% light gray, sugary dolomite	7749 —	7761
4	Limestone; dark gray with 10-20% brown, dense, pyritic limestone. Also a little above dolomite	7761 —	7765
4	Limestone; dark gray with an equal amount of brown, fine, dense, pyritic limestone. Also a very little dolomite	7765 —	7769
6	Limestone; light brownish gray, very fine, dense	7769 —	7775
6	Limestone; dark gray with an equal amount of brown, fine, dense limestone	7775 —	7781
14	Limestone; dark gray to brownish gray	7781 —	7795
17	Limestone; dark brownish gray, pyritic. A little milky chert from 7801-7805′	7795 —	7812
21	Limestone; dark brownish gray, very fine and dense	7812 —	7833
4	Limestone; dark gray to dark brownish gray	7833 —	7837
9	Limestone; brownish gray, more coarsely crystalline than above. Contains a little crystalline dolomite	7837 —	7846
8	Limestone; dark brownish gray, shaly, fossiliferous	7846 —	7854
15	Limestone; brownish gray, coarsely crystalline, fossiliferous	7854 —	7869
4	Limestone; gray, pyritic. Has a shaly appearance	7869 —	7873
13	Limestone; gray, highly fossiliferous, shaly	7873 —	7886
24	Limestone; light gray, fossiliferous. Coarsely crystalline	7886 —	7910
16	Limestone; light gray, fossiliferous, shaly	7910 —	7926
12	Limestone; light gray, fossiliferous. Coarsely crystalline	7926 —	7938
24	Limestone; dark brownish gray, dense. Breaks in small chips. (Salt water—½ bailer per day somewhere between 7900′ and 8000′)	7938 —	7962

Anhydrite

Thickness feet	Description of Strata	Top	Bottom
16	Dolomite; gray with considerable anhydrite	7962 —	7978
22	Dolomite; gray banded. Contains a little anhydrite at base	7978 —	8000
5	Limestone; brown, dense. Breaks in small chips	8000 —	8005
7	Dolomite; gray with considerable anhydrite	8005 —	8012
6	Dolomite; gray	8012 —	8018
16	Dolomite; gray, small amount of anhydrite; also a small amount of brown limestone	8018 —	8034
16	Limestone; brown (Light and dark), flakey	8034 —	8050
59	Limestone; dark gray and brown	8050 —	8109
4	Limestone; dark gray and brown, small amount of gray dolomite	8109 —	8113
4	Dolomite; gray—50% dark gray and brown limestone	8113 —	8117
11	Limestone; dark gray and brown, small amount of dolomite	8117 —	8128
9	Dolomite; gray, small amount of anhydrite	8128 —	8137
7	Dolomite; brownish gray, sugary. Occasional fragment of anhydrite	8137 —	8144
4	Dolomite; gray	8144 —	8148
4	Limestone; dark gray	8148 —	8152
19	Limestone; brown to brownish gray, dolomite	8152 —	8171
3	Dolomite; gray, sugary with a small amount of anhydrite	8171 —	8174
	Total depth		8174

Subsurface section no. 2
Indiana Savings Bank well no. 1
Sample log by Fred Whiteside

Description of strata
Mississippian series
Pocono 408 feet +

Thickness feet		*Cumulative thickness in feet* *Top*	*Bottom*
75	Boulders and sandstone	0	75
45	Sandstone, dark gray, fine	75	120
10	Sandstone, dark gray, yellow, coarse	120	130
16	Sandstone, dark gray, yellow, fine	130	146
2	"Slate," white	146	148
12	Sandstone, dark gray, yellow, fine	148	160
2	Limestone and limy shale, red	160	162
5	"Slate," black	162	167
25	Shale, black	167	192
8	Sandstone, dark gray and yellow, coarse	192	200
5	Shale, reddish	200	205
10	Sandstone, reddish, fine	205	215
8	Shale, sandy, gray	215	223
10	Sandstone, gray, dark and brown shells	223	233
7	Shale, black	233	240
8	Sandstone, dark; shells, brown	240	248
7	Shale, sandy, dark gray	248	255
3	Sandstone, gray and yellow, coarse	255	258
2	Sandstone, brown, coarse	258	260
5	Sandstone, gray	260	265
10	Shale	265	275
18	Sandstone, dark	275	293
3	Shale	293	296
7	Sandstone, dark	296	303
2	Shale	303	305
10	Sandstone	305	315
5	"Slate," black	315	320
3	Sand, limy	320	323
10	Sandstone, brown, gray, limy (oil smell, 328 feet)	323	333
30	Limestone, dark gray	333	363
35	"Slate," dark	363	398
2	Clay, yellow	398	400
1	Shale, brown	400	401
3	Lime shells	401	404
4	Conglomerate	404	408

Upper Devonian 6,039 feet?
Oswayo 350 feet?

Thickness feet		*Top*	*Bottom*
4	Sandstone, blue	408	412
21	Sandstone, gray, hard, cemented by lime	412	433
1	Shale, gray	433	434
16	Sandstone, with blue-black chert	434	450
6	Sandstone, gray, hard, cherty, lime cement	450	456
18	Sandstone, gray	456	474
11	Sandstone, gray, cherty	474	485
9	Shells, limy	485	494
6	Sandstone, dark blue, very cherty, hard	494	500
7	Shale and sandstone, blue, limy, cherty	500	507
18	Sandstone, gray, fine, hard, tightly cemented	507	525
6	Slate, sandy, gray	525	531

Thickness feet		Cumulative thickness in feet	
		Top	Bottom
6	Sandstone, gray	531	537
4	Shale, gray, limy	537	541
13	Shale, sandy	541	554
26	Sandstone, blue-gray	554	580
5	Sandstone, shaly, dark gray	580	585
11	Sandstone, shaly, gray	585	596
4	Shale, gray	596	600
10	Sandstone, gray	600	610
17	Sandstone, dark gray, coarse	610	627
6	Sandstone, light gray, fine	627	633
71	Sandstone, dark gray, coarse	633	704
5	Clay, light gray	704	709
41	Sandstone, light gray	709	750
8	Sandstone, gray	750	758

Catskill facies 441 feet?

Thickness feet		Top	Bottom
10	Sandstone, garnet (reddish)	758	768
5	Sandstone, gray	768	773
53	Sandstone, garnet (reddish)	773	826
11	Sandstone, gray	826	837
10	Clay, garnet (reddish)	837	847
47	Sandstone, garnet (reddish)	847	894
31	Sandstone, dark gray	894	925
30	Sandstone, light gray	925	955
95	Sandstone, garnet (reddish)	955	1050
48	Sandstone, dark gray	1050	1098
101	Sandstone, light garnet (reddish)	1098	1199

Chemung and Portage facies 5203 feet?

Thickness feet		Top	Bottom
10	Sandstone, dark gray	1199	1209
44	Sandstone, light and dark gray	1209	1253
106	Sandstone, dark gray	1253	1359
23	Sandstone, light gray	1359	1382
40	Limestone, light and dark gray	1382	1422
8	Sandstone, dark gray	1422	1430
22	Sandstone, light brown	1430	1452
43	Limestone, light gray	1452	1495
10	Limestone and shale	1495	1505
5	Sandstone, light gray	1505	1510
10	Limestone and shale	1510	1520
15	Sandstone, light gray	1520	1535
10	Limestone, dark gray	1535	1545
15	Sandstone, light gray, limy	1545	1560
15	Limestone, light gray, shale, garnet (reddish)	1560	1575
25	Sandstone, light gray, coarse	1575	1600
15	Sandstone, tan, fine	1600	1615
35	Limestone, dark gray	1615	1650
30	Sandstone and lime, dark gray	1650	1680
50	Limestone, dark gray	1680	1730
75	Sandstone, light gray	1730	1805
40	Sandstone, steel gray	1805	1845
50	Shale, garnet (reddish)	1845	1895
33	Limestone, light gray	1895	1928
27	Limestone and sandstone	1928	1955
5	Limestone, gray	1955	1960
33	Limestone and shale, gray and garnet (reddish)	1960	1993

Thickness feet		*Cumulative thickness in feet*		
		Top		*Bottom*
23	Limestone, light gray	1993	—	2016
84	Limestone, gray, shale, garnet (reddish)	2016	—	2100
45	Limestone, light gray	2100	—	2145
15	Sandstone, gray and garnet (reddish)	2145	—	2160
270	Limestone, light and dark gray	2160	—	2430
15	Sandstone, steel gray, fine	2430	—	2445
15	Sandstone, tan, fine	2445	—	2460
135	Limestone and sandstone, gray	2460	—	2595
5	Limestone and sandstone, gray	2595	—	2600
25	Sandstone, gray	2600	—	2625
10	Shale, garnet (reddish) limestone, gray	2625	—	2635
10	Sandstone, white	2635	—	2645
200	Limestone, gritty	2645	—	2845
50	Slate	2845	—	2895
20	Limestone, black	2895	—	2915
541	Limestone, gritty	2915	—	3456
374	Limestone, sandy, hard	3456	—	3830
10	Limestone, pink	3830	—	3840
16	Slate	3840	—	3856
14	Limestone, black	3856	—	3870
12	Slate, black	3870	—	3882
14	Slate, brown	3882	—	3896
18	Limestone, gritty	3896	—	3914
26	Limestone, broken	3914	—	3940
25	Limestone, gray	3940	—	3965
41	Slate	3965	—	4006
22	Limestone, sandy	4006	—	4028
24	Slate, brown	4028	—	4052
18	Slate, black	4052	—	4070
18	Limestone, white	4070	—	4088
10	Sandstone and limestone pebbles	4088	—	4098
37	Limestone, broken	4098	—	4135
90	Limestone, gritty	4135	—	4225
56	Limestone, black	4225	—	4281
3	Slate	4281	—	4284
26	Limestone, broken	4284	—	4310
50	Limestone, dark, gritty	4310	—	4360
8	Slate	4360	—	4368
30	Limestone, dark	4368	—	4398
3	Slate	4398	—	4401
17	Limestone, sandy	4401	—	4418
12	Sandstone, brown	4418	—	4430
30	Limestone, gritty	4430	—	4460
12	Slate	4460	—	4472
6	Limestone, hard	4472	—	4478
28	Slate and shells	4478	—	4506
12	Shale, sandy	4506	—	4518
28	Slate and shells, black	4518	—	4546
12	Limestone	4546	—	4558
112	Slate and shells, black	4558	—	4670
80	Slate and shells, soft	4570	—	4750
50	Slate and shells, hard	4750	—	4800
5	Limestone, pink	4800	—	4805
27	Shells, broken	4805	—	4832
138	Slate and shells, dark	4832	—	4970
10	Limestone, hard	4970	—	4980
90	Slate and shells, brown	4980	—	5070
136	Slate and shells, dark, hard	5070	—	5206

Thickness feet		*Cumulative thickness in feet*	
		Top	*Bottom*
10	Rock, black, fine	5206	5216
52	Slate and shells	5216	5268
6	Rock, black, hard	5268	5274
6	Slate and shells	5274	5280
5	Rock, black, hard	5280	5285
15	Slate and shells	5285	5300
5	Rock, black and red	5300	5305
79	Slate and shells	5305	5384
21	Rock, hard, black	5384	5405
25	Slate and shells	5405	5430
10	Slate and shells, brown	5430	5440
8	Limestone, hard	5440	5448
52	Slate and shells, cave	5448	5500
5	Sandstone, white pebbles, gas	5500	5505
75	Sandstone, broken	5505	5580
8	Slate, soft	5580	5588
5	Limestone, hard	5588	5593
19	Slate and shells	5593	5612
3	Sandstone	5612	5615
86	Slate and shells, sandy	5615	5701
127	Slate and shells	5701	5828
14	Shale, brown	5828	5842
118	Slate and shells	5842	5960
149	Limestone, hard	5960	6109
55	Slate and shells	6109	6164
90	Slate and shale	6164	6254
104	Slate and shale, brown	6254	6358
44	Slate and lime	6358	6402
45	Lime, sandy. (Tully?)	6402	6447
115	Shale, sandy	6447	6562
134	Slate, soft, black	6562	6696
57	Slate, soft	6696	6753
8	Limestone, gray, hard	6753	6761

Well deepened under name of Indiana Savings Bank

239	Shale, dark gray, sandy, some pyrite, calcite and lime shell	6770	7009
147	Shale, dark gray, occasional lime shale and calcite	7009	7156
47	Shale, dark gray, occasional lime shell and calcite	7156	7203
27	Shale, black, calcite	7203	7230
72	Shale, dark gray, calcite	7230	7302
6	Shale, black, calcite	7302	7308
4	Shale, gray, calcite (gas pocket at 7308)	7308	7312
6	Shale, gray, calcite and quartz	7312	7318
11	Shale, dark gray, calcite and quartz	7318	7329
5	Shale, dark gray, calcite	7329	7334
40	Shale, dark gray, limy, calcite	7334	7374
14	Shale, dark gray, limy, calcite, pyrite	7374	7388
35	Shale, dark gray, calcite, some pyrite	7388	7423
11	Shale, calcite, pyrite	7423	7434
8	Shale, black, calcite, pyrite	7434	7442
10	Shale, dark gray, calcite, pyrite	7442	7452
15	Shale, dark gray, pyrite	7452	7467
5	Shale, dark gray, pyrite, calcite	7467	7472
19	Shale, black, calcite, pyrite	7472	7491
2	Shale, gray, calcite, pyrite	7491	7493
16	Shale, limy, dark gray, pyrite, calcite	7493	7509

Thickness feet		*Cumulative thickness in feet* *Top*		*Bottom*
20	Shale, limy, black, pyrite, calcite	7509	—	7529
10	Shale, limy, black, pyrite, calcite, some quartz	7529	—	7539
10	Shale, limy, dark gray, pyrite, calcite	7539	—	7549
14	Shale, limy, black, pyrite, calcite (lime and shells 7578)	7549	—	7563
	Onondaga			
21	Dolomite, calcite, chert	7563	—	7584
81	Limestone, buff to reddish brown, calcite, chert (Gas, 750M at 7671)	7584	—	7665
29	Limestone, dark gray, hard, crystalline	7665	—	7694
	Oriskany			
6	Sandstone, light gray to white, angular quartz grains (Large flow of salt water at 7722.5)	7694	—	7700
	Total depth			7700

STRUCTURE

DEFINITION

Geologic structure is that part of the geology of a region which pertains to the attitude or position of the rocks with relation to the horizontal, and the nature and amount, if any, of the deformation they have undergone. In western Pennsylvania the rocks were originally deposited as sediments in an inland sea in approximately horizontal layers. Since their deposition and solidification, they have been subjected to great pressure, apparently from the southeast, which pushed the rocks into folds having a general northeast-southwest trend. The folds are relatively mild west of the Allegheny Front and gradually die out toward the northwestern part of Pennsylvania. East of the Allegheny Front the folding was more intense and the rocks have been fractured, overturned, faulted, and overthrust and the structure is very complex.

The axes of the folds are not horizontal, but rise higher or sink lower in some areas than in others, and give a plunging character to the structure, forming domes and saddles. The axes do not form straight lines, but rather tend to be sinuous; they are only roughly parallel.

USES OF GEOLOGIC STRUCTURE

A geologic structure map is useful in development of mining projects and prospecting for oil and gas. Mines may be so located as to take advantage of the dip of the bed to give natural drainage and down-grade for haulage of loaded cars. The relation that structure bears to the production of oil and gas is discussed farther on in this report.

With a geologic structure map, a prospector may, for instance, at any given point determine the vertical distance to an underlying or overlying coal bed. This is accomplished by adding to or subtracting from the elevation of the reference bed upon which the structure contours are based, the average interval between the two strata.

METHODS OF REPRESENTING STRUCTURE

The method employed to represent the geologic structure of a region depends upon the nature of the structure of that region. Where rocks are steeply folded and faulted, as in eastern Pennsylvania, the structure is represented by the dip and strike method, which consists of the use of symbols indicating the direction of the strike and the direction and amount of the dip at a particular locality; or by drawing a series of cross sections. In western Pennsylvania where the angle of dip is relatively low, and where coal beds can be traced rather easily, the best method and the one commonly employed to represent detailed structure in this part of the State, is the use of contours similar to those representing the topography.

The structure contour method is used in the New Florence quadrangle. It consists of first selecting a suitable reference stratum or key bed having extensive outcrop and one which can be easily identified. Although the linear outcrop of the Lower Kittanning coal is limited in this area, it was selected as a base for structure datum because of its persistent and widespread distribution, and also because of its economic importance. It was the objective in the majority of the exploratory core drill holes, particularly where the horizon is below drainage or at considerable distances in from the outcrop. Elevations above mean sea level were determined on this bed at outcrop from mine surveys and from core drill holes where the elevation of the top of the hole was known, or on a recognizable bed above or below. The elevation of the Lower Kittanning coal was calculated by subtracting from the bed above, and by adding to the bed below, the nearest known vertical distance between these two strata. Many such points were determined, plotted on the topographic map at their exact locations, and lines drawn through points having equal elevations. For example, 50 feet was selected as the contour interval or distance between lines, then lines were drawn at 1,200, 1,250 and 1,300 feet; and show that the Lower Kittanning is 50 feet vertically higher or lower than the next line. The intersection of a surface contour line with a structure contour line of the same elevation indicates a point above sea level of outcrop of the Lower Kittanning coal. Each structure contour is coincident with a line which may be traced along the bed at a given depth.

It follows then that these structure contour lines not only show the position of the Lower Kittanning coal in relation to the topography, but the approximate position of other valuable beds might be located in any part of the quadrangle by consulting the stratigraphic section for the interval between the Lower Kittanning coal and the bed sought.

DETAILED STRUCTURE

The rocks of the New Florence quadrangle are folded into alternating high arches, anticlines, and deep basins, synclines. These open folds, roughly parallel, trend in a northeast-southwest direction, and are reflected in the topography; the anticlines forming the mountains and the synclines forming the valleys. The structural highs or elongated domes on the anticlinal axes are concordant with the topographic highs. The detailed structure is shown on the accompanying geology and mineral resources map (Plate 1), in the pocket of this report (see also cross section Plate 7). In this area there are two major anticlines and two major synclines, with a minor anticline and a minor syncline extending into the quadrangle. Beginning at the east the major structural features are the Laurel Hill anticline, the Ligonier syncline, the Chestnut Ridge anticline and the Latrobe syncline. The minor structures consist of the plunging noses of the Nolo anticline and the Brush Valley syncline, extending into the quadrangle from the northeast.

Laurel Hill anticline.

The Laurel Hill anticline is one of the more prominent structures in western Pennsylvania. It extends from West Virginia, where it is called the Briery Mountain anticline, and crosses Fayette, Westmoreland, Cambria and Clearfield Counties into Clinton and Lycoming Counties where it is called the Hyner anticline. The axis of the anticline follows the crest of Laurel Hill which extends 8½ miles across the southeastern part of the New Florence quadrangle, forming two elongated domes; a northeastward plunge begins near the eastern boundary of the quadrangle. The fold is slightly asymmetrical, the west flank being slightly steeper. The flanks are fairly regular in outline and have a maximum dip of about 1,100 feet per mile; the strike is generally North 25°E.

Ligonier syncline.

The Ligonier syncline begins in southeastern Fayette County and dies out in southwestern Clearfield County, where it is called the Barnesboro syncline. It extends in a northeast-southwest direction across the New Florence quadrangle as a broad, irregularly-shaped structural and topographic basin, and its axis lies from about 4 to 6½ miles west of the axis of the Laurel Hill anticline. From the structural basin at the southwest which has its center a little north of Old Colony, the sinuous axis rises irregularly from about 50 feet in 0.7 of a mile to 50 feet in 3.9 miles passing north of Wilpen, Fort Palmer; through West Fairfield, New Florence, and Seward and leaves the quadrangle east of Armagh. The east limb is fairly regular in outline and rises from about 100 feet to 350 feet per mile to the foot hills of Laurel Hill. The west limb has a generally similar attitude as it rises to the foot hills of Chestnut Ridge at the southwest, but north of West Fairfield and New Florence the outline of the limb becomes very irregular. It rises at the rate of approximately 300 feet in two miles, with the strike varying from nearly due east to due north. A prominent structural bulge occurs between New Florence and Bolivar.

Chestnut Ridge anticline.

The Chestnut Ridge anticline is probably the most prominent and certainly the most continuous structure in western Pennsylvania, and may be traced from West Virginia northeastward across Pennsylvania to the

New York State line in Bradford County where it is called the Wellsboro anticline. From an elongated dome at the head of Snyders Run along the west-central boundary of the quadrangle, the axis plunges southwestward at the rate of 250 feet in .9 miles to where it leaves the quadrangle. Northeastward the axis is mildly sinuous and plunges without interruption to the north-central boundary of the quadrangle. The northeastward plunge varies between 50 feet in 0.2 of a mile to 50 feet in 1.1 miles. South of the Conemaugh River the plunge is more rapid and the crest of the ridge is narrow; north of the river the angle of plunge becomes progressively less steep and the crest of the ridge is broader. The anticline is somewhat asymmetrical; the eastern limb is for the most part a little shorter. The maximum dip is about 1,100 feet per mile, but south of the Conemaugh River the east limb is interrupted by a strike fault, and southeast dips up to 85 degrees were observed.

Latrobe syncline

The Latrobe syncline extends from Fayette County where it is known as the Uniontown syncline. It crosses Westmoreland County and dies out to the northeast in southern Indiana County. This structure has an important bearing on the economy of this region because very large tonnages of the valuable Pittsburgh coal was preserved in its basin. The axis of this syncline occupies 5 miles of the northwestern part of the New Florence quadrangle and plunges mildly to the southwest passing near McCrea Row, Campbells Mill and Smith. The center of the basin is fairly broad and the flanks rise gradually from it. Influenced by the Chestnut Ridge anticline, the east limb is the steeper, rising about 250 feet per mile toward the foot hills of the Ridge.

Nolo anticline

The Nolo anticline has an extent of about 20 miles and lies mostly in eastern Indiana County. It enters the northeast corner of the New Florence quadrangle as a nearly symmetrical southwest-plunging nose of a dome which centers a short distance to the northeast. The axis plunges southwestward at the rate of about 100 feet per mile to Blacklick Creek near Dias where it turns due west. The anticline loses its identity just east of Heshbon.

Brush Valley syncline

Between the Nolo and Chestnut Ridge anticlines is the Brush Valley syncline which extends from southeastern Indiana County into southwestern Clearfield County, and is about 34 miles long. The axis enters along the east-central boundary of the New Florence quadrangle north of Claghorn. Rising southwestward at about 150 feet per mile, it dies out against the eastern limb of Chestnut Ridge anticline west of Heshbon.

Faulting and Jointing

Strong indication of faulting is found on the east flank of Chestnut Ridge anticline south of the Conemaugh River where the Connoquenessing (Pottsville) sandstone, striking generally north 35 degrees east and dipping from 40 to 85 degrees southeast, forms a conspicuous hogback running parallel to the ridge. This strike fault may be traced from the western boundary of the quadrangle to near the river. Due to concealment by talus from Pottsville sandstones, the actual fault surface was not seen. In Bear Pond Hollow and in the ravine 0.7 miles to the northeast the Connoquenessing sandstone apparently is in contact with the Loyalhanna limestone, thus displacing the Mauch Chunk which is about 120 feet thick. Drag folding is indicated at the latter locality where a small exposure of Loyalhanna shows a northwest dip, a dip direction which opposes the general southeast dip on this flank of the anticline. On the spurs adjacent to Bear Pond Hollow, the dip of Pottsville sandstone changes abruptly from 70 degrees southeast to about 11 degrees southeast.

An overturned fold is indicated in the fault zone on the township road crossing Chestnut Ridge near the western boundary of the quadrangle (Ac. 7). There, incompetent red beds in the lower part of the Conemaugh series apparently are infolded with beds of the older Allegheny series.

A tear fault of some magnitude is inferred where the course of the Conemaugh River flowing northward from Bolivar turns abruptly westward into the gorge. The fault is inferred on the basis of the difficulty in matching structure contour lines in opposite sides of the river. The lateral extent of the fault zone is something over 1,000 feet, and it is arbitrarily drawn in and near the river bed. It may also be inferred that the abrupt change in the course of the Conemaugh River was influenced by a fault.

An east-dipping drag fold in Mauch Chunk beds is well exposed in a cut on the railroad on the south side of the river. Its relationship, if any, to the major fault could not be established. Other lesser drag folds occur in cuts along the railroad to the west; they probably represent minor local adjustment.

Faulting at depth is evidenced in some wells drilled for natural gas by the Peoples Natural Gas Company on the west side of an elongated dome of Chestnut Ridge anticline near the western boundary of the quadrangle. The Camilla F. Griffen no. 1 well (Ab 18), which started in the top of the Pocono sandstone, penetrated the Tully limestone at depths of 7,235 and 7,990 feet. The well was completed at 8,050 feet (see well log page 00). That this structure becomes increasingly complex with depth was verified in the Camilla F. Griffen no. 4 well located 0.4 of a mile north from no. 1 well (Ab 17), which also was started near the top of the Pocono sandstone. The sample study of the well made by R. E. Bayles of the Peoples Natural Gas Company is presented in part below and shows that after reaching the Onondaga limestone, at 7,228 feet, the Oriskany sandstone was encountered t 7,392 feet, 8,133 feet and 9,163 feet; a thrust fault of relatively little displacement was crossed at 8,730 feet. Surficial indication of faulting i the immediate vicinity of the wells was not observed. Minor drag fold occur near and west of the axis of the anticline along the railroad on th south side of the Conemaugh River.

The complex faulting at depth in the Griffen no. 1 and 4 wells, and th possible relationship to the faulted zone on the east limb of Chestnut Ridg anticline, is shown in a graphic interpretation by Carlyle Gray on Plate

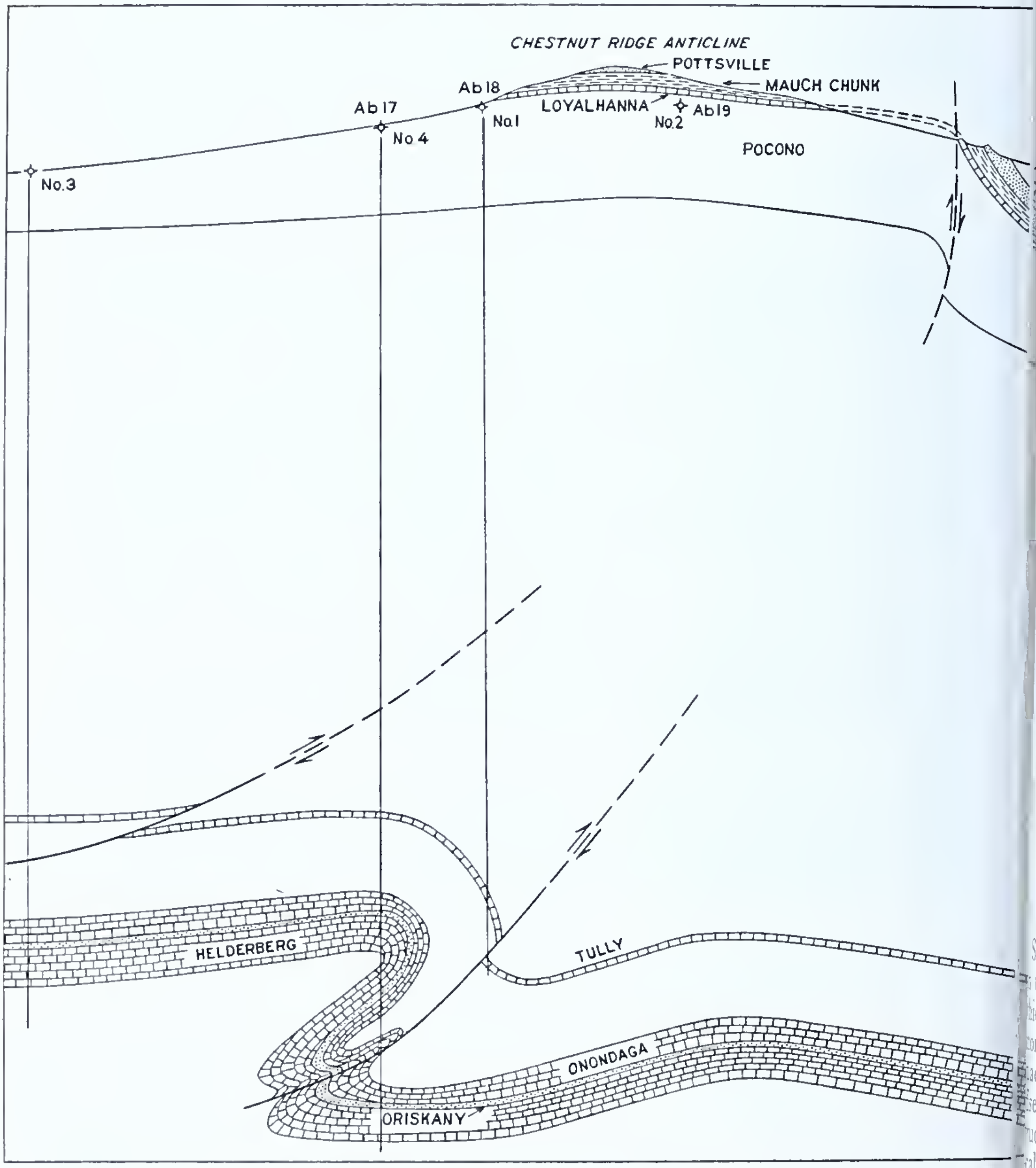


PLATE 8. DIAGRAM SHOWING FAULTING AT DEPTH ON CHESTNUT RIDGE ANTICLINE
BY CARLYLE GRAY

Sample log of Camilla F. Griffen no. 4 well from 6445 feet to 9163 feet

	Top	*Bottom*
	feet	
Tully limestone	6445	6449
Hamilton-Marcellus shales	6449	7228
Onondaga formation	7228	7392
"Brown Break" 7228		
Chert 7258-7392		
Oriskany sandstone	7392	7457
Helderberg	7457	7810
Silurian	7810	7854

At approximately 7854 feet the well started through an overturned section.

The section in reverse order continues:

	Bottom	*Top*
Silurian	7854	7898
Helderberg	7898	8133
Oriskany sandstone	8133	8205
Onondaga formation	8205	8402
Chert 8205-8365		
"Brown Break" 8402		
Marcellus-Hamilton shales	8402	8524

At approximately 8524 feet the well again crossed a recumbent fold and began drilling through beds in their normal position.

	Top	*Bottom*
Hamilton-Marcellus shales	8524	8647
Onondaga formation	8647	8730
"Brown Break" 8647		
Chert 8702-8730		

At 8730 feet the well crossed a thrust fault of relatively little displacement, but crossed into an overturned section in the down-thrown block.

	Bottom	*Top*
Onondaga formation	8730	8748
"Brown Break" 8748		
Marcellus-Hamilton shales	8748	8856

At approximately 8856 feet the section again recovered itself, and the well is now drilling through beds in their normal stratigraphic position.

	Top	*Bottom*
Hamilton-Marcellus shales	8856	8964
Onondaga formation	8964	
"Brown Break" 8964		
Chert 9006		
Oriskany 9163		

Subsequent geologic mapping by the author in preparation for a report n the geology and mineral resources of the Donegal quadrangle (1956) hich is southwest of the New Florence quadrangle, revealed a structural nomoly on Chestnut Ridge anticline near the northern boundary of the uadrangle. There, on the basis of surface mapping, the anticlinal axis is ffset by a distance of approximately 1 mile, and a fault is inferred. This tructural offset is supported by offsets of topographic "highs" in the same cality. Additional support of a fault in this locality was found in two ells drilled for natural gas.

The Peoples Natural Gas Company's Booth and Flynn no. 2 well o Loyalhanna Creek in the Latrobe quadrangle to the north is, according t present mapping (Campbell 1904), on the Chestnut Ridge anticline. Th well, at an elevation of 1,121 feet, was drilled to a depth of 7,428 feet, an penetrated the top of the Oriskany sandstone at a depth of 6,807 feet, or a an elevation of –5,686 feet.

The same company's William Piper no. 1 well also on Chestnut Ridg anticline is about 4 miles southwest of the Booth and Flynn no. 2 well i the Donegal quadrangle. The Piper well, starting at an elevation of 206 feet, was drilled to a depth of 8552 feet, and encountered the top of th Oriskany sandstone at a depth of 8,301 feet, or at an elevation of –6,24 feet.

The northeastward axial plunge of the anticline from the Piper well t the Booth and Flynn well is approximately 250 feet. The Oriskany sand stone in the Booth and Flynn well, therefore, would normally be expecte to occur at a position 250 feet lower than where it is in the Piper well, o at an elevation of –6,807 feet. The Oriskany in the Piper well occurs at a elevation of –6,240. Considering the plunge of the axis, it should occur 25 feet lower or at –6,490 feet at the Booth and Flynn well. However, occurs at –5686 feet which is 804 feet shallower than the predicted depth and provides good evidence for faulting in the locality.

Considerable jointing is found in the rocks in some areas. These joint are arranged in definite sets with those belonging to one set trending in th same general direction, with the better developed sets known as the maste joints. These nearly vertical features represent zones of weakness in th rocks. As a rule they become closed in depth, but on the surface, they ma be enlarged by mechanical and chemical erosional forces. In massiv homogeneous rocks such as sandstones and conglomerates, joints may b widened many feet. These large intersecting joints are called "rock cities A fairly good example may be seen on the crest of Chestnut Ridge nort of Bear Pond Hollow in the Pottsville sandstones. Huge blocks of thes sandstones have worked down the mountain sides many hundreds of fe distant from the outcrop.

Data are insufficient to determine definitely if the master joint system in the rocks in this area are the result of compressional or tensional forc However, the major folds probably are due to compressional forces whi were applied from the southeast and it therefore seems reasonable assume that these relatively minor features are also compressional in origi

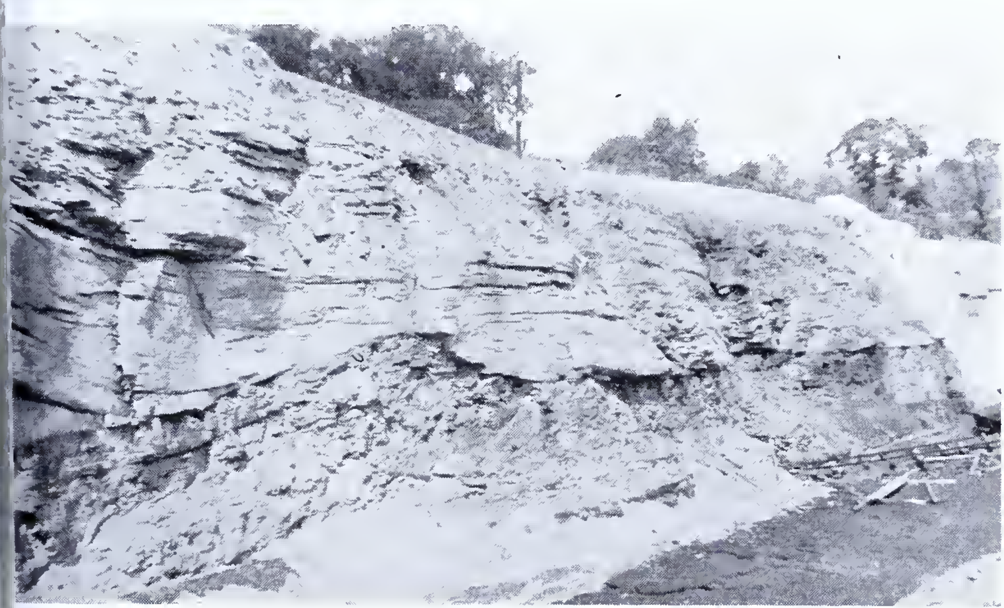
Jointing is better exemplified in the face cleat of coal beds. This set joints is particularly well developed, exhibiting smooth, nearly vertic surfaces which range from less than an inch to over 12 inches apart. Fro field evidence, they are at approximately right angles to the strike of t axes of the folds and are classified as dip joints. Their directional tren or strikes vary from north 50 degrees west to north 80 degrees west. T orientation of the face cleat is an important factor in developing t working face of a coal mine, because the coal readily breaks out from t face cleat.

Butt cleats or strike joints are generally poorly developed or obscu They also are nearly vertical and form an angle of about 90 degrees wi he face cleats and are roughly parallel to the axes of the folds. A set of nclined cleats is developed locally. They are closely spaced, have smooth right surfaces and dip from about 40 degrees to 50 degrees toward the xes of the folds. Apparently, these joints are confined to certain parts of he coal bed and are believed to be the result of shearing in locally ncompetent parts of the coal bed.

Although data concerning the jointing in shales, sandstones and limetones are meager, a well developed set of master joints have a general rend from about north 20 degrees west to north 35 degrees west and form n angle of approximately 60 degrees with the trend of the structural axes. he reasons for this angular difference are not well understood.

UNCONFORMITIES

The unconformity of large proportions at the base of the Pottsville series as previously discussed in the chapter dealing with the Mississippian ystem. Relatively minor unconformities having an observed relief up to 0 feet, are prevalent particularly in the Conemaugh-Allegheny series. hey are local in character and are the result of unevenly eroded surfaces nd channeling whereon sediments of a different type, commonly sandtone, were deposited. These relatively minor unconformities may have een a factor in modifying the ultimate thickness locally, but the thinning f the major geologic divisions is gradual and conforms with the regional rends of thinning in directions away from source material. Minor local nconformities are displayed in the high walls of some coal strip mines. n excellent exposure was observed in a strip mine near Torrance where he Mahoning sandstone lies on the unevenly eroded roof shales of the pper Freeport coal (Aa 52) (Figure 8).



GURE 8. Mahoning sandstone lying on unevenly eroded roof shale of Upper Freeport coal, in strip mine east of Torrance.

Mineral Resources

The most important mineral resource in the New Florence quadrangle has been, is now, and will probably continue to be, coal. The Pittsburgh coal at the base of the Monongahela series was preserved as relatively small erosional remnants in the Ligonier and Latrobe synclines, but the bed is worked out. The Allegheny series underlies large areas in the quadrangle, and contains at least three coal beds that have present economic value. Plastic underclays occur and some may have considerable value. Sandstone and siliceous limestone are available in almost limitless quantities. Relatively thin deposits of argillaceous limestone suitable for local agricultural purposes are associated with coal horizons. Shales are abundant but the quality is not known to have been tested. There are thin scattered deposits of secondary iron oxides and carbonates but they do not have present economic value.

Natural gas is produced from shallow sands in the lower Mississippian and upper part of the Devonian in the northern part of the quadrangle. A few scattered shallow tests elsewhere failed to find gas in commercial quantities. Some unsuccessful wells have been drilled to the deep Oriskany "sand" but large structurally favorable areas remain to be tested.

The ensuing discussion considers the character, quality and distribution of these resources. A discussion of the occurrence of ground water is also included.

Geology and Mineral Resources Map

The major geologic divisions are shown on the geology and minera resources map (Plate 1) by patterns and symbols. The boundaries of the geologic divisions are delineated by black lines. The heavier brown lines on the map represent the structure contours. They are drawn on the Lower Kittanning coal bed, and show the actual surface of that horizon as it would look if all the overlying strata were removed and all of the underlying strata restored in the areas where part of them have been eroded.

Outcrops of important coal beds are shown on the map in black lines. The identity of the coals may be determined by comparing their map symbols with those in the explanation at the right. Where outcrop lines are broken, the presence of the bed is doubtful or concealed. The discontinued lines indicate that either the bed is erratic in occurrence, or that not enough data were available to justify drawing the outcrop line farther. The unbroken outcrop lines, however, do not necessarily mean that the presence of a specified bed is certain, or that its outcrop is exposed. In mapping practice the continuity of a bed is inferred between observed exposures. Commonly, a mantle of soil or talus conceals the outcrop, but the horizon usually can be traced by recognizing seeps of water from impervious underclay of a coal bed, or by noting the topographic expression o a bench and terrace.

To facilitate reference between map and text, the rectangles formed by the 5-minute lines of latitude and longitude are taken as reference units. The vertical rows are designated by capital letters, and the horizontal rows by small letters. As an example, Ba 3 refers to a datum point in the second vertical row from the left and the first horizontal row from the top.

COAL

Origin and Character

The fossil plant impressions found in coal and in the strata closely ssociated with coal beds indicated long ago that coal is of vegetable origin. icroscopical studies of coal confirmed not only that assumption but, in ddition, enabled determination of the kinds of plants that form coals. t has also been established that the partially decayed plant material ccumulated in vast swamps and bogs as peat. The peat accumulation as buried under later sediments and was subsequently converted to coal. he weight of overlying sediments, degree of deformation of the strata, and ccompanying heat determine the rank of the coal as it is now found. The ngth of time that the above factors affect the coal also contributes to the resent rank.

Beginning with peat, the accumulated material is increased in rank as llows: peat, lignite, sub-bituminous, bituminous, semi-bituminous, anracite, and meta-anthracite. The end product of increased rank is raphite.

Coals have certain megascopic physical characteristics in terms of color, anding, structure, luster, streak, hardness or friability, and jointing.

Color. In the mass and in powdered form, bituminous coals of Pennsylania are black.

Banding. Bituminous coals commonly consist of alternating bright and ull bands (Thiessen 1920). The bright bands (anthraxylon) have been etermined to consist mainly of wood changed into coal as shown by the oody cell structures detected microscopically; dull bands (attritus) const of small pieces of wood, leaves, branches and bark, besides pollen rains, spores, and the resinous, waxy and fatty contents of cells and tissues.

Structure. With the exception of fusain (mineral charcoal) which has cellular structure like that of charred wood most of the bituminous coals re massive.

Luster. Coals differ in luster from a dull gray-black lacking luster to a itreous black luster (e.g. the brilliant luster of anthracite).

Streak. The color of the streak of Pennsylvania bituminous coal is milar to the color of its massive form: black. The streak is obtained by ıbbing a piece of coal on a plate of unglazed porcelain, or scratching with knife.

Hardness. Coals differ in hardness; some are friable, whereas others are ugh and break across the bedding plane with difficulty.

Fracture and jointing. Bituminous coals commonly break into rectanılar, nearly rectangular, or cubical blocks of various sizes. Jointing in coal is exhibited by two sets of cleats: the more prominent joint is term the face cleat; the less evident cleat, generally at a right angle to the fa cleat, is called the butt cleat.

Weight and specific gravity. The weight of a cubic foot of solid co differs according to the rank and the ash content. The weight of coal in bed is obtained by multiplying the specific gravity of the coal by 62 pounds, the weight of a cubic foot of water. The specific gravity of co is determined by comparing the weight of coal with the weight of an equ volume of water. The specific gravity of most of the bituminous coals Pennsylvania lie between 1.30 and 1.40.

IMPURITIES IN COAL

Coal beds are seldom free from impurities of some character such as bo shale, clay and pyrite. The shale and clay represent silty conditions due fluctuations in water level at the time of coal-formation. These partin and/or binders (coal parts freely from partings, and adheres to binder vary in number, and in thickness range from a knife edge up to more th 2 feet in vertical extent. Some persist in thickness and position in the b over a relatively wide area thus furnishing a clue to the correlation of t coal. Irregular nonpersistent lenses and disseminated fine particles pyrite ("sulphur") are common constituents of coal beds; fusain appea to have been replaced by sulphur locally. Sulphur in its various for must have been deposited by percolating waters which carried it in sol tion. Clay dikes or squeezes intrude along vertical cracks or joints, whi probably were widened from release of pressure following erosion of thi overlying strata. This hypothesis is supported by the fact that clay dik generally become numerous toward the outcrop where overburden thinner. Fractures may also become filled with gypsum. Coal usual contains inherent impurities of finely disseminated silt and sulphur whi cannot be removed by ordinary cleaning methods.

CLASSIFICATION OF COALS

To meet the needs of both scientific and commercial interests, coals ha been classified according to their inherent properties and compositio (American Society for Testing Material. Report of sectional committ on classification of coals, 1934); 1. By rank, or according to the degree metamorphism, or progressive alteration in the geological series fro lignite to anthracite. 2. By grade, or according to quality as determin by calorific value, ash and sulphur content, ash-softening, size, etc. 3. B type or variety such as common banded, splint, cannel and boghead algal coals. The standard classification of coal by rank is recorded

Table 1. As can be seen from this table the high-rank bituminous coals and anthracite are classified according to fixed carbon on the dry basis, and the lower-rank bituminous subbituminous and lignite coals according to B.t.u., on the moist basis—that is, containing its natural bed moisture, but free from visible surface moisture. The proximate analysis of coal was used. On the basis of this classification, coals are divided into four major classes, each class of which is further divided into two to five groups.

When the dry, mineral-matter-free fixed carbon is more than 69 percent, the classification is effected by using the fixed carbon; and when the dry, mineral-matter-free fixed carbon is less than 69 percent the classification is

TABLE I.—CLASSIFICATION OF COALS BY RANK.[a]

Legend: F.C. = Fixed Carbon. V.M. = Volatile Matter. Btu. = British thermal units.

Class	Group	Limits of Fixed Carbon or Btu. Mineral-Matter-Free Basis	Requisite Physical Properties
I. Anthracitic	1. Meta-anthracite	Dry F.C., 98 per cent or more (Dry V.M., 2 per cent or less)	
	2. Anthracite	Dry F.C., 92 per cent or more and less than 98 per cent (Dry V.M., 8 per cent or less and more than 2 per cent)	
	3. Semianthracite	Dry F.C., 86 per cent or more and less than 92 per cent (Dry V.M., 14 per cent or less and more than 8 per cent)	Nonagglomerating
II. Bituminous[d]	1. Low volatile bituminous coal	Dry F.C., 78 per cent or more and less than 86 per cent (Dry V.M., 22 per cent or less and more than 14 per cent)	
	2. Medium volatile bituminous coal	Dry F.C., 69 per cent or more and less than 78 per cent (Dry V.M., 31 per cent or less and more than 22 per cent)	
	3. High volatile *A* bituminous coal	Dry F.C., less than 69 per cent (Dry V.M., more than 31 per cent); and moist[c] Btu., 14,000[e] or more	
	4. High volatile *B* bituminous coal	Moist[c] Btu., 13,000 or more and less than 14,000[e]	
	5. High volatile *C* bituminous coal	Moist Btu., 11,000 or more and less than 13,000[e]	Either agglomerating or nonweathering[f]
III. Subbituminous	1. Subbituminous *A* coal	Moist Btu., 11,000 or more and less than 13,000[e]	Both weathering and nonagglomerating
	2. Subbituminous *B* coal	Moist Btu., 9500 or more and less than 11,000[e]	
	3. Subbituminous *C* coal	Moist Btu., 8300 or more and less than 9500[e]	
IV. Lignitic	1. Lignite	Moist Btu., less than 8300	Consolidated
	2. Brown coal	Moist Btu., less than 8300	Unconsolidated

[a] This classification does not include a few coals which have unusual physical and chemical properties and which come within the limits of fixed carbon or Btu. of the high-volatile bituminous and subbituminous ranks. All of these coals either contain less than 48 per cent dry, mineral-matter-free fixed carbon or have more than 15,500 moist, mineral-matter-free Btu.

[b] If agglomerating, classify in low-volatile group of the bituminous class.

[c] Moist Btu. refers to coal containing its natural bed moisture but not including visible water on the surface of the coal.

[d] It is recognized that there may be noncaking varieties in each group of the bituminous class.

[e] Coals having 69 per cent or more fixed carbon on the dry, mineral-matter-free basis shall be classified according to fixed carbon, regardless of Btu.

There are three varieties of coal in the high-volatile C bituminous coal group, namely, Variety 1, agglomerating and nonweathering; Variety 2, agglomerating and weathering; Variety 3, nonagglomerating and nonweathering.

made by using the moist, mineral-matter-free B.t.u. Weathering and agglomerating properties are used to differentiate between certain adjacent groups. The method of calculating to the mineral-matter-free basis by Parr (1928) formulas is given below:

$$\text{Dry, Mm-free F.C.} = \frac{\text{F.C.} - 0.158}{100-(\text{M}+1.084 + 0.55\text{S}) \times 100}$$

Dry, Mm-free V.M.—Dry, Mm-free F.C.

$$\text{Moist, Mm-free B.t.u.} = \frac{\text{B.t.u.} - 50\text{S}}{100-(1.08\text{A}+0.55\text{S}) \times 100}$$

Where:

Mm = mineral matter
B.t.u. = British thermal units
F.C. = percentage of fixed carbon
V.M. = percentage of volatile matter
M = percentage of moisture
A = percentage of ash
S = percentage of sulphur

ANALYSIS OF COAL

There are two kinds of coal analysis; ultimate and proximate. The ultimate is a strictly chemical process and shows the percentages of the principle elements, as carbon, hydrogen and oxygen. It is mainly of scientific interest. The proximate analysis is the determination of moisture, volatile matter, ash, fixed carbon and sulphur. The proximate analysis is less costly, better suited for practical purposes and, aside from the determination of sulphur, strictly chemical analyses are avoided.

Following is a brief description of the above properties of coal. For methods of determination the reader is referred to American Society for Testing Materials on Coal and Coke (1949).

Moisture. Moisture is retained in coal in three ways: first, mechanically on the surface of the face and butt cleats which may or may not be present; second, hygroscopic moisture, which is held in the pores by capillary attraction, and retained in the coal when air-dried; and third, moisture in a form or forms not clearly understood.

Volatile matter. Volatile matter in coal consists of the combustible gases hydrogen, carbon monoxide, methane and other hydrocarbons together with inert gas and water formed by the decomposition of the coal, but does not include the moisture and possible other gases which may be expelled when coal is heated for one hour from 104 to 110 degrees C. Large quantities of heat are lost in high volatile coals due to incomplete burning of the gases.

Ash. Ash is the incombustible solid material remaining after coal is burned. Chemical analysis of ash show that it consists mainly of alumina (Al_2O_3), lime, (CaO), silica (SiO_2), iron oxide (Fe_2O_3), magnesia (MgO), and sulphur compounds. A high ash content is an objectionable impurity because it has no fuel value; it adds to the cost of shipment, as one per cent of ash represents about 20 pounds per ton; it increases the cost of ash removal from furnaces, and is in itself capable of forming clinkers, if its fusion temperature is relatively low.

Fixed carbon. Fixed carbon is the difference between 100 and the moisture plus volatile matter plus ash. However, this does not represent all of the carbon in the coal, as a considerable quantity, combined with hydrogen, is driven out in the volatile matter. Carbon has a high heat value. As a general rule, coals in which the fixed carbon ranges between 77 and 81 per cent offer best opportunities for deriving the full heat of both fixed carbon and volatile matter.

Sulphur. Sulphur is always present in coal in variable quantities (up to 8 per cent or more). It exists in both organic and inorganic compounds. Organic sulphur compounds which have been identified in coal are derived from the protein sulphur of plants from which coal was formed. The inorganic sulphur occurs as sulfate or sulfide. The sulfate is present in minor amounts as iron and calcium sulfates and are fairly soluble. The sulfide occurs as iron pyrite and lesser amounts of marcasite concentrated in balls as concretions, and lenses or as minute disseminated particles. The pyrite oxidizes to the sulfate on exposure to air which is generally leached out because of its solubility.

Sulphur combined with iron is easily dissociated by heat, the sulphur passing off as a gas and the iron oxidizing to a state in which it readily combines with other gases to form clinkers. More than 2 per cent sulphur has a tendency to lower the fusion point and cause clinkering of the ash.

Heat value. The heat value of coal is usually expressed in British thermal units (B.t.u.). It is the quantity of heat required to raise one pound of water (at 15 degrees C., or 62 degrees F) one degree F°.

Analysis into elemental constituents tells almost nothing about coal as a chemical substance. Due to its complexity, the exact chemical structure is unknown. As the derivatives from coal distillation were studied, their molecular structure fell into two geometric divisions. From coal tars came a series of organic compounds called aromatics, the basic unit being benzine (C_6H_6). From coal gas came another series of compounds the aliphatics, the basic unit being methane, the simplest of hydrocarbons. These series of compounds proved to be cornerstones of synthetic organic chemistry. With simpler coal derivatives as starting points, molecules could be built up, linked and rearranged by various reactions adding or substituting other elements such as oxygen, nitrogen, sulphur, or chlorine to form a vast variety of compounds with different properties. Approximately 500,000 compounds have been synthesized. These compounds embrace the whole range of synthetic dyes, perfumes, plastics, fibers, rubbers, explosives, etc. Throughout this development the exact molecular structure of coal remains a mystery. How coal is put together chemically is difficult to determine.

Analyses of coal

Analyses of coals in the New Florence quadrangle are presented in the accompanying tables. The analyses in Tables no. 7 and no. 8 were made by U. S. Bureau of Mines (T.P. 590, 645). Table no. 8 gives proximate analyses of coal as shipped and delivered, and they are prepared primarily for purchasers and consumers. Samples are taken after the coal is mined and has received customary cleaning. It may be sampled at the mine either when the coal is being loaded for shipment or while it is being unloaded at the point of delivery. The latter analyses indicate more nearly what consumers are likely to receive. The samples are collected according to the American standard method. (Pope, G. S., 1917). Table no. 7 consists of proximate and ultimate analyses of mine samples, which represent the coal in place, and are intended for use by mine operators. The samples are collected according to the standard method adopted by the U. S. Bureau of Mines and the Geological Survey. (Holmes, 1918). A mine sample contains the best quality of coal that can be produced, because the sampler excludes impurities in the bed and those arising from roof and floor conditions. An average or composite analysis of a number of face samples will show a lower percentage of ash than the analyses of run-of-mine coal from the same mine, the reason being that the miner is primarily interested in producing large tonnages and might become careless in excluding impurities.

Ultimate analyses and B.t.u. for mine samples are given for three conditions, as follows: (1) as received; (2) moisture-free; and (3) moisture- and ash-free. Proximate analysis and B.t.u. for tipple and delivered samples are recorded on the as-received and moisture-free basis. The as-received condition represents the sample as received at the laboratory and for mine samples approximates closely the condition of coal in the mine; the moisture-free condition the composition, and heating value of the dry coal. The moisture- and ash-free condition approximates the composition and heating value of dry combustible matter. The analyses are rounded to the nearest 0.1 per cent, and the British thermal units to the nearest 10, although the laboratory determinations are recorded to the nearest 0.01 percent and to the closest British therman unit.

The agglomerating index (not given in Tables 7 and 8) is a rough indication of the coking properties of coal. It is determined by visual and physical examination of the residue from the standard volatile-matter determination. The fusibility or softening temperature of coal ash is defined as the temperature at which a cone of the ash, when heated under prescribed conditions in the test furnace with a slightly reducing atmosphere, has fused down to a spherical lump.

For further details on sampling methods, chemical analysis, methods of testing etc. the reader is referred to American Society for Testing Materials Standards on Coal and Coke, 1949.

The general progressive increase in proportion of volatile matter of coal from eastern to western Pennsylvania has long been attributed to physicochemical alteration associated with Appalachian deformation. Modification or anomalies of the general pattern are thought to be due to influence of variable thickness of overlying strata in developing temperatures and pressures. The low of 5 per cent volatile matter in the anthracite fields of eastern Pennsylvania, increases to 42.5 per cent in the extreme western part of the State.

Isovols

The isovols (lines of equal volatile matter content) shown on the Coal Reserves maps, Plates 9, 11, were interpolated from scattered analyses of Upper Freeport and Lower Kittanning coals in the northern part of the quadrangle. The progressive increase in the moisture and mineral-matter free volatile matter from east to west is evident. Isovols on the Lower Kittanning coal trend generally northeast, and intersect isovols on the Upper Freeport coal which trend more to the north. A nearly direct vertical comparison of analysis of Lower Kittanning and Upper Freeport coals at Bolivar show 22.9 percent volatile matter for the former, and 26.8 percent for the latter, or a difference of 3.9 percent; the Lower Kittanning—Upper Freeport interval being about 200 feet. Although a number of bed analyses from a mine show that the volatile matter varies up to 2.6 percent within a relatively short distance, there is still indication that lower coals show slightly less volatile matter content.

Low-volatile Lower Kittanning coal underlies the area east of the 22 percent isovol, which is delineated by a curved line drawn arbitrarily through East Wheatfield and West Wheatfield townships; the Lower Kittanning, Lower Freeport and Upper Freeport coals north and west of the 22 percent isovol line in the quadrangle are of the medium-volatile bituminous rank.

Rank and Coking

Perch and Russell (1949) show that there is sufficient evidence obtained from past experience to indicate that characteristics of coke produced from a given coal are in some measure related to the rank of coal. Broadly, the high-volatile C bituminous coals make very small fragile cokes if the coal cokes at all; whereas the high-volatile A coals produce much better cokes. Although the low-volatile bituminous coals produce strong cokes, they should not be carbonized unblended in by-product coke ovens, because they swell and exert excessive pressures against the oven walls.

Preparation Characteristics

The Pittsburgh coal bed in southwestern Pennsylvania has long supplied most of the coal used for manufacture of coke in both beehive and by-product ovens. Because of its low sulphur content it required no mechanical cleaning, and in areas where the maximum sulphur percentage increased to 2 percent or more it could be cleaned by simple washing methods.

The easily accessible reserves of this fabulous coal bed are rapidly diminishing, and it is virtually exhausted in the New Florence quadrangle. In view of the not too distant depletion of the Pittsburgh coal, attention has recently been directed toward study of thinner, inferior quality of coals to determine their preparation characteristics. The U. S. Bureau of Mines (1951) has published reports on the preparation characteristics of coals in Indiana (R.I. 4763) and Westmoreland (R.I. 4823) Counties.

History of Mining

Coal was first mined in the New Florence quadrangle at Lockport in 1806. It was transported in sacks for fuel in the forge connected with Hermitage furnace which was situated near Oak Grove, about 1½ miles northeast of Ligonier. The coal probably was the Upper Freeport. The Pittsburgh coal was discovered near Ligonier in 1808 following what was called the "Pumpkin" Flood, which washed away the surface and disclosed the coal. Since the Pittsburgh coal occurs high on the hills in this area, it is extremely doubtful that the flood waters rose to those levels. What probably was meant was that excessive rainfall preceding the flood washed gullies, disclosing the presence of the Pittsburgh coal.

Coal was at first dug without explosives, hauled from the drift in wheelbarrows and transported in wagons. The railroad from Philadelphia to Pittsburgh was opened in 1852 and some mines were developed along the Conemaugh River. The first shipments were small, and little was done in the industry until 1877, after the panic of 1873. Commercial production was first reported from a mine, probably in Upper Freeport coal, at Lockport in 1892. Production from additional mines was reported in the early 1900's. The increase was gradual until great impetus was given the coal industry during World War I and continued during the boom years following, but dropped off appreciably with the depression which began about 1930. Coal mining was again accelerated with World War II, and continued for a short time thereafter.

Coal held a commanding lead as a source of energy until 1953 when for the first time in its history it fell to a position behind oil. Coal supplies 34 percent of the nation's total B.t.u.'s as compared to 39.4 percent for crude oil, 22.5 percent for natural gas and 4.1 percent for water power. Coal in the last half century has lost its most lucrative markets to more convenient fuel oil and natural gas for heating. Railroads have converted from steam to diesel-electric motive power. Utilities are still the biggest users of bituminous coal, but though the output of electric power is increasing, the efficiency of burning is continually being improved: In 1947, 1.31 pounds of coal produced 1 kilowatt-hour, in 1954, 1 pound of coal produced 1 kilowatt-hour. Institutional and industrial steam power plants with modern burning equipment are generating more pounds of steam per unit coal, and the steel industry is producing more steel per ton of coke.

Loss in leadership of the coal industry is due in part to its slow progress in mining methods; it was slow to mechanize and modernize, with a loss in efficiency when costs were rising. The industry persisted in regarding coal primarily as a fuel. It knew little of its product beyond the fact that it burned, whereas the petroleum industry began early to do basic research on its raw materials. Most of the knowledge about coal is recent and derived by research of chemical industries.

Coal operators are now making some gains by meeting competitive fuels on a cost-production basis. Labor costs represent from 50 to 60 percent of mining costs, but development of continuous mining machines, and improved conveying and transportation equipment have greatly increased the tons-per-man output. Research to improve mining preparation and utilization is expected to reduce production costs. Roof bolting, which eliminates mine timbering and provides maneuverability at the working face is an important advancement; as is also the development of auger mining machines which recover coal more than 100 feet in from the high wall limit in strip mines. The industry presently has an optimistic outlook.

Coal Production

The production of coal in the New Florence quadrangle, as compiled from Pennsylvania Department of Mines reports from 1892 to 1952, amounts to 56,330,000 tons of which 21,041,000 tons was produced from the Pittsburgh bed, 9,886,000 tons from the Upper Freeport, 1,740,000 tons from the Lower Freeport and 23,663,000 tons from the Lower Kittanning bed. An additional large quantity of coal was produced from strip mines, but it is impossible to compile the amount from the reports. Total production by individual mine is given in the ensuing detailed discussion of the coal beds.

Mining Methods

The room-and-pillar system or a modification thereof is commonly practiced in the New Florence area. Most are drift mines, a few are slopes. At least two main parallel headings are driven in from the outcrop; one is for haulage, the second is the ventilating entry, with a fan at the mouth. The headings are driven up the dip of the coal to facilitate haulage and natural drainage from the mine.

The coal is undercut with pick or cutting machine and "shot" down with permissible explosives. Modern mining equipment had not been installed up to 1951. The commercial mines are electrified and haulage is by electric locomotives. Mule haulage ("Hay-burner locomotive") is common in the small custom mines.

Coal is extracted both advancing from the surface opening and retreating from the property boundaries. Systems of development and extraction vary according to the conditions met at each individual mine. Robbing of pillars with collapse of roof is also practiced to some extent.

Either power shovels or drag lines are used to remove the overburden in strip mining. The opening cut, which is 50 to 100 feet wide is started some distance in from the outcrop, where the coal is solid and relatively unweathered. The spoil or excavated material is wasted on the side toward the outcrop. When the coal is uncovered, scrapers remove the extraneous material and bony, if present, from the top of the coal.

A loading shovel follows the stripping shovel and loads the coal into trucks for transportation to a loading dock on a railroad, or the coal may be delivered directly to the consumer. In succeeding cuts, the stripping shovels deposit the spoil on the area from which the coal has been previously removed.

The normal economic limit of overburden or the height of high wall averages about 30 feet depending upon the type of rock material and the ability of the equipment. Bulldozers equipped with pushing blades remove the loose cover in successive cuts when the overburden increases. The rule-of-thumb for the economic limit of overburden is one foot of overburden to one inch of coal, but this is necessarily modified by the type of rock to be removed, and the quality of coal. Soft shales can ordinarily be removed without preparation, but hard shales and sandstones have to be drilled and blasted, which adds considerably to the cost of removal.

It is practically impossible to remove the thinner partings or binders which can be gobbed in deep mining. The ash content in strip mine coal is therefore relatively high, unless it is processed in cleaning plants.

Pittsburgh Coal

As previously stated, the Pittsburgh coal is economically exhausted in the New Florence quadrangle and, although it no longer represents an economic resource in this area, it merits some discussion because of its fabulous contribution to the economy of Pennsylvania.

Deposits of Pittsburgh coal are rapidly being depleted elsewhere in Pennsylvania. The bed has remarkable continuity and is distributed over an area of approximately 5,000 square miles (Cross 1954) including southwestern Pennsylvania, eastern Ohio, northern and western West Virginia and a small part of western Maryland. The tonnage in the original deposit, before mining, is estimated to be about 40 billion tons. It was largely because of the presence of the coal bed, that the steel industry was established in Pittsburgh. There has been more wealth produced from the Pittsburgh coal than from any single mineral deposit in the world.

The Pittsburgh coal was preserved in the New Florence quadrangle as detached erosional remnants in the Latrobe and Ligonier synclines, totaling about 4,250 acres, with an estimated original deposit, before mining, of approximately 48,900,000 tons. The compiled reported production from deep mine operations is 21,000,000 tons, which would be a little less than 50 percent recovery. However, it was learned from former mine foremen that actual recovery is something over 70 percent.

Large scale commercial mining of the Pittsburgh coal began in the quadrangle early in the 1900's and the mines reached their economic limits in the 1930's. The remaining recoverable pillars were being worked by a few small operators when this survey was made. Subsidences along the outcrop indicate that the coal had been mined out to the "grass roots" at most places, and not much solid coal was available for strip mining, but apparently some strip operators failed to recognize these indications.

In the New Florence quadrangle the Pittsburgh coal bed has a normal range in thickness from 6 to 8 feet; it is commonly topped by a few inches of bony coal, and contains a rather persistent binder or parting in the lower part of the bed which is a characteristic that is generally prevalent in other regions. The moisture and sulphur contents are low, but the ash is commonly over 10 percent. The Pittsburgh coal is medium volatile bituminous rank in the Ligonier syncline and high volatile bituminous rank in the Latrobe syncline.

A thick bed of coal, unique and apparently local in character occurs above the Pittsburgh coal in a mine in the Latrobe syncline north of Campbells Mill (Aa8). In the fall of 1949 the Lyda Coal Company purchased the abandoned Clawson mine to work remaining pillars. It was planned to make a new entry on a pillar, but before this development was started, the road from the mine to the highway was to be improved. A small power shovel while digging into the hillside for material to surface the road, uncovered a thick bed of coal, which at the time was considered a pillar left in the mine. A heading started into the bed and as it was advanced the coal became increasingly thicker, attaining a maximum thickness of 14 feet. Eventually, the shale floor at one place in this drift caved into what was discovered to be the workings in the actual Pittsburgh bed, the top of which at this point was four feet below the upper coal. Although the mine in the lower or main Pittsburgh bed was inaccessible, an authority said the coal is normally 6 feet thick, and that the bed is uneven and considerably reduced in thickness at some places indicating local erosion. The upper coal bed is very irregular in thickness and is cut out completely by sandstone at some places. A shale binder up to 18 inches thick, occupies an irregular position in the lower part, and sandstone lenses occur frequently in the upper part of the coal. Similar coal deposits in the area are not known, and the Pittsburgh bed is eroded to the northeast. Evidence of channeling may suggest a detrital origin.

Most of the Pittsburgh coal mined in this region was transported to steel mills for the manufacture of coke. A small amount was coked in beehive ovens at Wilpen.

The larger mining companies that worked the Pittsburgh coal in the New Florence quadrangle were the Graff Coal Co. in Latrobe syncline; the Westmoreland-Connellsville Coal and Coke Co., Greensburg-Connellsville Coal and Coke Co., St. Clair Fuel Co., Batan Coal Co., Shenango Furnace Co., and the Old Colony Coal Co., in the Ligonier basin.

Upper Freeport Coal

The Upper Freeport "E" coal at the top of the Allegheny series is one of the more valuable coal beds in the bituminous fields of Pennsylvania and has been mined extensively. It is called the Cap Seam in the Moshannon basin in Center County, the Lemon Coal in Cambria and Blair counties, the Coke Yard seam in the Johnstown basin and is also locally called the Four Foot seam.

The Upper Freeport is also an important coal bed in the New Florence quadrangle and has been mined since 1806; commercial development began at Lockport in 1891. About 17 commercial mines worked the Upper Freeport at various times, and the total reported production from deep mines up to and including 1952 is something over 9 million tons. The horizon of the coal underlies 80,587 acres. Of this it is estimated that 16,686 acres is underlain by coal 0 to 14 inches thick, and 63,901 acres is underlain by coal over 14 inches thick, before mining. About 2,284 acres have been mined out and lost, leaving 61,607 acres of potential reserves remaining. Reserves of Upper Freeport coal are given in table 2. Plate 9 shows the reserves of the Upper Freeport coal in the New Florence quadrangle. The coal is generally of medium-volatile bituminous rank.

The physical characteristics, habit and distribution of the Upper Freeport coal are discussed with respect to five districts in the quadrangle.

They are in order of discussion as follows: The Blacklick-Strangford district, Bolivar-Robinson district, Heshbon-Scottglen district, New Florence-Seward district and the Southeast district.

Blacklick-Strangford District

The Blacklick-Strangford district includes southeastern Blacklick, western Burrell, northeastern Derry, northwestern West Wheatfield and southern Center townships.

Coral mine. The Upper Freeport coal was worked in the Coral mine at Coral on the Indiana Branch of the Pennsylvania Railroad (Aa 5). This was a slope mine with electric haulage. The mine opened in 1912 as the Potter mine of the Wharton Coal Company. It was acquired later by the Coral Coal Company renamed the Coral mine and operated until 1939. A total of 4,412,000 tons of coal was reportedly produced. An unknown quantity of coal was stripped south of the pit mouth of the mine. The area of development when operations were discontinued included approximately 358 acres. There is adjacent to this developed area about 623 acres and 518 acres of coal classified respectively as measured and indicated reserves. (Plate 2).

The daily output of the mine was about 800 tons and 80 percent was from advance workings. The system of mining was room and pillar. The coal was undercut by machine and shot down by permissible explosives. It was crushed by breaker to one-half inch and the bony was removed; 3 percent of the coal was run-of-mine; 97 percent was washed and coked in 300 behive ovens. (Figure 9.)

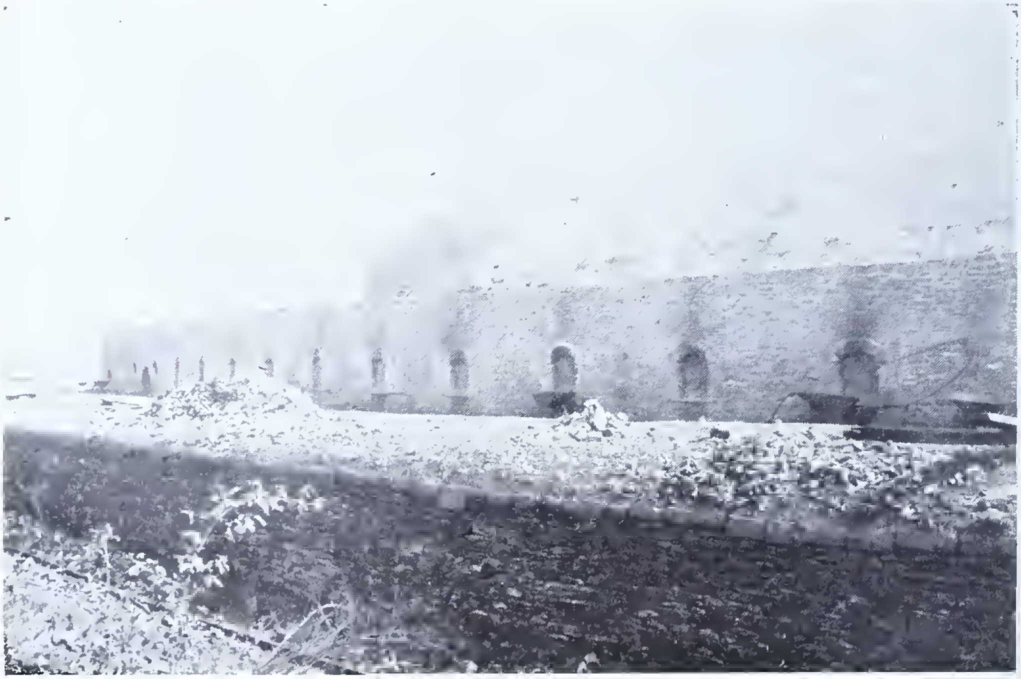


Figure 9. Beehive coke ovens, at Coral.

The normal range in the bed thickness is from 60 to 70 inches, in its thicker development it is separated into two benches by 6 to 11 inches of bony coal. Nonpersistent sulphur binders are also present in various parts of the bed. The following are sections of the coal bed measured at four points in the mine by personnel of U. S. Bureau of Mines in 1922 (See analysis tables 7, 8).

Sections of Upper Freeport coal in Coral mine (Aa 5)

Section	A		B		C		D	
Laboratory No.	85506		85507		85508		85509	
Roof, shale	*Ft.*	*In.*	*Ft.*	*In.*	*Ft.*	*In.*	*Ft.*	*In.*
Canned coal		[a]4		[a]4		[a]5		[a]3
Coal	1	3	1	5	1	6	1	6
Bony streaked coal		[a]10		[a]11		[a]10		[a]9½
Coal	1	8	3	3		6	3	6
Sulphur		[a]½	..	..		[a]½	..	..
Coal	1	11	..	..	2	10	..	..
Floor, shale								
Thickness of bed	6	½	5	11	6	1½	6	½
Thickness of sample	4	10	4	8	4	10	5	0

[a] Not included in sample

Section A was taken at face of 8 room, 4 flat section. Section B was taken at face of 19 room, 2 slope, 3½ flat section. Section C was taken at face 7 room, 2 slope 3 flat section, 4 butt heading. Section D was taken at face 1 room, 2 slope 2½ flat section.

Berenni mine. The Berenni mine is located northeast of Josephine (Aa 6). It is a small, active custom operation, and up to and including 1951 produced more than 65,000 tons of Upper Freeport coal. A section measured just inside the pit mouth is as follows:

Section of Upper Freeport Coal in Berenni mine (Aa 6)

	Ft.	*In.*
Roof shale		
Coal, with some knife-edge partings	1	9
Shale parting		10
Coal, with some knife-edge partings and lenses of fusain	3	4
Floor, clay		
Thickness of coal section	5	10

Strangford mine. The Strangford mine is on the Pennsylvania Railroad on the north side of the Conemaugh River east of Strangford (Aa 50). The pit mouth is at an elevation of about 975 feet. This was originally a pick mine with a daily output of 150 tons from advance workings. Mining began in 1904 and was suspended in 1923, with a total production of 711,000 tons; the coal was produced as run-of-mine. An area of about 326 acres has been developed; large quantities of minable coal are still available. The coal is medium-volatile bituminous having a normal bed thickness of 42 inches with a 1-inch bony coal parting in the lower part. The bed was measured and sampled at three points by personnel of U. S. Bureau of Mines in 1922 (See analysis table 7).

Sections of Upper Freeport coal in Strangford mine (Aa 50)

Section	A		B		C	
Laboratory No.	85657		85658		85659	
Roof, shale	*Ft.*	*In.*	*Ft.*	*In.*	*Ft.*	*In.*
Coal and sulphur	..	..	..	..		[a]1
Coal	2	10	2	10	2	9
Bony coal		[a]1		[a]1		[a]1
Coal		9		8		7
Floor, fireclay:						
Thickness of bed	3	8	3	7	3	6
Thickness of sample	3	7	3	6	3	4

[a] Not included in sample

Section A was taken at face 23 butt heading, dip flat heading. Section B was taken at face of 1 room, 28 right heading, main flat heading. Section C was taken at face of 1 room, 29 right heading, main flat heading.

About one-half mile east of the Strangford mine (Aa 51) the Upper Freeport coal was strip-mined in a single cut which extends along the outcrop for approximately 2000 feet. The immediate cover is shale up to 10 feet thick; and the cap rock is medium-bedded Mahoning sandstone, at least 15 feet thick.

Packsaddle mine. The Packsaddle mine is on the main line of the Pennsylvania Railroad east of Torrance (Aa 54). This was a small operation having a daily output of about 40 tons of medium-volatile Upper Freeport coal per day from advance workings. The mine was opened in 1920 and abandoned in 1922, with a total reported production of 18,000 tons, sold as run-of-mine. The coal is roofed by a variable thickness of shale; the cap rock is Mahoning sandstone. The coal bed is normally 40 inches thick, it is topped by 2 inches of bony and contains a 1½- to 2-inch shale parting in the lower part. The bed was measured and sampled by personnel of U. S. Bureau of Mines in 1922 as follows: (See analysis Table 7.)

Sections of Upper Freeport coal in Packsaddle mine (Aa 54)

Section	A		B	
Laboratory No.	85403		85404	
Roof, shale	*Ft.*	*In.*	*Ft.*	*In.*
Coal and sulphur		[a]2		[a]2
Coal	2	6	2	6
Shale		[a]1½		[a]2
Coal		7		6½
Floor, fireclay:				
Thickness of bed	3	4½	3	4½
Thickness of section	3	1	3	½

[a] Not included in sample

Section A was taken at face of dip aircourse, 250 feet from mine mouth. Section B was taken at face of main entry, 600 feet from mine mouth.

Some Upper Freeport coal was produced in a strip mine (Aa52) just north of the Packsaddle mine where the following section was measured:

Section of Upper Freeport coal in strip mine (Aa 52)

	Ft.	*In.*
Cap rock, sandstone		
Roof, shale	0-20	0
Coal, with lenses of sulphur and fusain	2	10
Shale parting	0	1
Coal, with lenses of sulphur and fusain	0	9
Floor, clay		
Thickness coal section	3	8

South from Torrance. Direct observation on the Upper Freeport where it crops out on the foot hills of Chestnut Ridge south of Torrance was unobtainable. What apparently is the Upper Freeport was worked in two county banks south of Grays (Ab 8, 9) where its reported thickness is 28 inches. Farther south in the vicinity of Derry in the Latrobe syncline, the Upper Freeport is over 42 inches thick, and had been mined commercially.

Latrobe syncline. The Upper Freeport coal has been tested by numerous core drill holes at various places in the Latrobe syncline. The coal horizon is under less than 1000 feet of cover in the center of the syncline. The cover thins progressively toward the outcrop on Chestnut Ridge anticline. Approximately 3,900 acres are underlain by coal classified as measured reserves (Plate 9, see also Table 2).

The Upper Freeport was found at a depth of 500 feet in a core drill hole near Campbells Mill (Aa 22). The coal bed is 61 inches thick and contains a 1½- and 3½-inch binder or parting in the lower part (see detailed section Plate 2, section 1). An analysis of the coal by unknown authority shows the following: volatile matter, 25.65 percent; fixed carbon, 62.8 percent; ash, 11.65 percent.

A core drill hole north of Smith encountered the Upper Freeport at a depth of 670 feet (Aa 37) having a bed thickness of 57 inches (see Plate 2, section 2). The coal was found at a depth of 590 feet in a core drill hole east of Smith (Aa 36) where 54 inches of clean coal is indicated (Plate 2, section 3). A core drill hole west of Strangford (Aa 49) revealed 42 inches of indicated clean Upper Freeport coal at a depth of 540 feet (Plate 2, section 5). In the Latrobe quadrangle, about 1½ miles northwest of the above location, a hole drilled to a depth of 590 feet cored a section of Upper Freeport coal 34½ inches thick (Plate 2, section 4).

Presence of Upper Freeport in the area about the borough of Blacklick was revealed by six core drill holes (Aa 14, 12, 15, 16, 17) which show the bed thickness of the coal ranging from 24 to 49 inches (Plate 2, sections 8-11, Plate 4, sections 30, 31). The coal bed in these holes lies at depths ranging from about 100 to 325 feet.

Continuity of minable Upper Freeport lying at variable depths was established by fairly well distributed core drill holes in the area from south of Blacklick to just south of U. S. Route 22 (Aa 18, 24-27, 30, 31, 40, 46, 48). The bed thickness of the coal ranges from 32 to 57 inches, the thicker beds containing one or two binders or partings in the lower part. The coal is commonly roofed by shale and capped by Mahoning sandstone (Plate 2, sections 6, 7, 12, 13, Plate 3, Sections 1-3; Plate 4, Sections 32-37). Analyses of the coal cores from two of these holes made by unknown authority are as follows: Aa 24. Volatile matter, 24.35 percent; fixed carbon 63.41; ash 12.06 percent; sulphur 2.47 percent. Aa 46. Volatile matter, 27.19 percent; fixed carbon, 60.31 percent; ash, 12.5 percent; sulphur 2.0 percent.

Chestnut Ridge. The Upper Freeport crops out on the west limb of Chestnut Ridge; the coal is eroded from the top of the ridge south from U. S. Route 22, but due to the plunging axis of the anticline, some of it is preserved as disconnected remnants on and near the crest north of the highway. Apparently the bed has here undergone only minor deep mining and some quantities have been stripped; there still is some recoverable coal available. (Plate 9.) Following are sections of the Upper Freeport Coal:

A measurement of the bed was obtained in a strip mine south of Palmerton (Aa 45) which is as follows:

Section of Upper Freeport coal in strip mine south of Palmerton (Aa 45)

Cap rock, sandstone	*Ft.*	*In.*
Roof, shale	variable	
Coal, with thin shale partings and lenses of sulphur	3	1½
Shale parting	0	½
Coal, with thin shale partings and lenses of sulphur	0	10
Floor, clay		
Thickness of coal section	4	0

The Upper Freeport has a similar character and is under the same kind of cover where some of it was stripped mined to the north (Aa 44).

Section of Upper Freeport coal in strip mine south of Palmerton (Aa 44)

Cap rock, sandstone	*Ft.*	*In.*
Roof, shale	variable	
Coal, with thin shale partings and lenses of sulphur	3	0
Shale, parting	0	½
Coal, with thin shale partings and lenses of sulphur		10
Floor, clay		
Thickness of coal section	3	10½

A section of this coal bed measured in a strip mine south of Palmerton (Aa 29) is as follows:

Section of Upper Freeport coal in strip mine south of Palmerton (Aa 29)

Cap rock, sandstone	*Ft.*	*In.*
Roof, shale	6	0
Coal, clean	3	4
Floor, clay		

The Upper Freeport was covered where it was strip-mined to the east (Aa 28), but a rider coal, separated from the main bench by from 5 to 15 feet of shale, has the following section:

Section of Upper Freeport rider coal in strip mine south of Palmerton (Aa 28)

	Ft.	*In.*
Roof sandstone	10+	
Coal	0	4½
Shale parting	0	⅛
Coal	0	3½
Shale parting	0	1
Coal	0	6
Shale parting	0	⅛
Coal	0	7
Fusain	0	½
Coal	0	3
Floor, shale to top of Upper Freeport coal	5	0
Thickness of coal section	2	2

A section of the Upper Freeport and its rider coal was measured in a strip mine west of Ridge School (Ba 39) the section is as follows:

Section of Upper Freeport coal in a strip mine west of Ridge School (Ba 39)

	Ft.	*In.*
Cap rock, sandstone	25+	
Bony coal and clay, rider coal	0	8
Shale	5	0
Coal with sulphur streaks	1	0
Binder	0	1
Coal	0	1½
Shale with coal streaks	1	11
Shale	4	6
Clay	0	8
Coal, with thin sulphur streaks and shale partings	4	6
Thickness coal section	4	6

The following section of the Upper Freeport was exposed in a strip mine farther to the east (Ba 35):

Section of Upper Freeport coal in strip mine west of Ridge School (Ba 35)

	Ft.	*In.*
Cap rock, sandstone	20+	
Roof, clay	1	0
Bony coal	0	3
Coal, with thin shale partings and lenses of sulphur	3	2
Bony coal	1	3
Floor, clay		
Thickness of coal section	3	2

A section of the Upper Freeport in a strip mine northwest of Ridge School (Ba 36) is as follows:

Section of Upper Freeport in strip mine northwest of Ridge School (Ba 36)

	Ft.	*In.*
Cap rock, sandstone	15+	
Shale, carbonaceous	0	3
Coal, with thin shale partings	3	7
Bony coal	1	3
Floor, clay	3+	
Thickness of coal section	3	7

The Upper Freeport is thicker where the coal was strip-mined northwest of Ridge School (Ba 32). A section measured there is as follows:

Section of Upper Freeport in strip mine northwest of Ridge School (Ba 32)

	Ft.	*In.*
Cap rock, sandstone		
Roof, shale	10+	
Coal, with thin shale partings	1	3
Bony coal	0	8½
Shale parting	0	8
Coal, with thin shale partings and lenses of fusain	4	0
Floor, carbonaceous shale with plant impressions		
Thickness of coal section	4	

The following section of the Upper Freeport coal was exposed in a strip mine farther north (Ba 21).

Section of Upper Freeport in strip mine north of Ridge School (Ba 21)

	Ft.	*In.*
Roof, sandstone, "rolls" into coal bed at some places	25+	
Shale	0	3
Coal	1	2
Bony coal parting	0	8
Coal	4	2
Floor, shale		
Thickness of coal section	6	0

The overlying sandstone rolls into the coal at some places. The section below was measured in a strip mine to the east. (Ba 22.)

Section of Upper Freeport in strip mine northeast of Ridge School (Ba 22)

	Ft.	*In.*
Roof, sandstone		
Bony coal	1	7
Coal, with thin shale partings	3	0
Floor, clay		
Thickness of coal section	3	0

A section of the Upper Freeport was measured where it has been mined out east of Coral (Ba 1). It is as follows:

Section of Upper Freeport in abandoned mine east of Coral (Ba 1)

	Ft.	*In.*
Roof, sandstone		
Coal	1	6
Bony coal	1	0
Coal, with thin partings	4	4
Floor, clay		
Thickness of coal section	4	4

Bolivar-Robinson District

The Bolivar-Robinson district includes northern Fairfield township and southern West Wheatfield township. The Upper Freeport coal in this district has been mined for many years in large scale commercial operations, but there still are large reserves available. The outcrop of the coal comes to the surface in the Conemaugh River south of Lockport and in Tubmill Creek south of Bolivar and rises northwestward into the upland. The coal commonly occurs in two benches separated at about the middle by a variable thickness of shale; it is reportedly high in ash and sulphur.

Lacolle mine. The Lacolle is a drift mine located on Tubmill Creek south of Bolivar (Bb 20). The mine was opened in 1912 and operated by the Fairfield Coal and Coke Company until 1930, and continued as the Monarch mine until abandoned in 1935. The average daily output was 200 tons and the total reported production is 1,409,000 tons. Advance workings extended nearly 1½ miles south of the pit mouth. A large area, lying generally south and east of the developed area is underlain by large reserves (Plate 9).

The Upper Freeport has an unusual local development in the Lacolle mines. The bed is reported as having a thickness of 14 feet, being parted near the middle by as much as 20 inches of shale or bony coal. It is also reported that only the lower bench was mined. Following are sections and analyses of Upper Freeport coal in the Lacolle mine.

Sections and analyses of Upper Freeport coal in Lacolle mine at Bolivar (Bb 20)
(10 room 2nd entry right)

	Ft.	*In.*
Roof, sandstone	50	0
Bony coal	0	6
Coal with thin sulphur streaks (Sample No. 1)	2	6
Shale parting	0	9½
Coal with thin sulphur streaks (Sample No. 2)	3	6
Shale parting	0	2½
Bony coal	0	5½
Floor, clay		
Thickness of coal section	6	9½

	Sample No. 1 *percent*	*Sample No. 2* *percent*
Volatile matter	24.37	24.37
Fixed carbon	64.880	68.130
Ash	10.750	7.500
Sulphur	4.147	1.500
Phosphorus	.035	.010

(Face, 2nd entry left main slope)

	Ft.	*In.*
Roof, sandstone	50	
Bony coal	1	2
Coal with thin sulphur streaks (Sample No. 1)	2	1
Shale parting	1	0
Coal with shale and sulphur streaks (Sample No. 2)	3	6
Shale parting	0	2
Bony coal	0	8
Floor, clay		
Thickness of coal section	6	7

	Sample No. 1 *percent*	*Sample No. 2* *percent*
Volatile matter	23.65	22.67
Fixed carbon	67.20	70.94
Ash	9.15	6.39
Sulphur	4.929	1.276
Phosphorus	.029	.011

As evidenced by three core drill holes, the thick parting in the Upper Freeport thins and disappears to the south. Following are the core sections of the coal:

Section of Upper Freeport coal in core drill hole south of Bolivar (Bb 28)

	Ft.	In.
Roof, sandstone	35	
Shale	1	6
Coal	4	9
Shale parting	0	2
Coal	0	4
Floor, clay		
Thickness of coal section	6	5

Section of Upper Freeport in core drill hole south of Bolivar (Ab 10)

	Ft.	In.
Roof, sandstone	12	
Shale	1	2
Coal	4	3
Floor, clay		

Section of Upper Freeport coal in core drill hole south of Bolivar (Ab 11)

	Ft.	In.
Roof shale	25	0
Bony coal	0	6
Coal	4	7
Floor, bony coal		

A core drill hole was put down northwest of West Fairfield (Bb 34). Although the record of the hole was not obtainable, information from independent sources tends to confirm that the Upper Freeport coal is 60 inches thick, and lies at a depth of 245 feet which coincides with the depth as determined from surface data.

Ridgeview mine. The Ridgeview mine was operated by Ridgeview Coal Company from 1917 to 1931, when the operation was abandoned. The mine had a total reported production of 741,000 tons. This mine is west of and adjacent to the Lacolle mine (Bb 19), and the character of the Upper Freeport coal is reportedly similar, but clay veins and "rock roll" are numerous. Analyses of coal as shipped and delivered is shown on Table 8.

Workings on the hill to the west belonged to the Ridgeview operation, and the coal was being worked for custom trade in one of the drifts (Bb 17) where the following section was obtained:

Section of Upper Freeport Coal in custom bank southwest of Bolivar (Bb 17)

	Ft.	In.
Cap rock, sandstone		
Roof, shale		
Coal	3	0
Shale parting	0	2
Coal	3	2
Shale parting	0	4
Coal	0	6
Floor, clay		
Thickness of coal section	7	2

Analyses of coal as shipped and delivered is given in Table 8.

Bolivar no. 1 mine. The Bolivar no. 1 mine is located along the main line of the Pennsylvania Railroad at the east end of Bolivar (Bb 15). This mine was operated by the Greensburg Fuel Company in 1920, and had been operated successively by the Progress Fuel Co., Bolivar Cooperative Coal Company and the Bolivar Fuel Company. Mining operations were discontinued in 1952. The daily average output was 250 tons, and the total reported production is something over 270,000 tons. It is also reported that advance workings have reached the limits of the property but some recoverable pillars remain. The average thickness of the bed is 80 inches, sulphur and bony coal at the middle is difficult to clean. Clay veins, and "faults" of relatively large extent reduced the thickness of the coal and cut it out at some places in the mine. An analysis of run-of-mine coal is given in Table 00.

McFeeley Brick "E" mine. The McFeeley Brick "E" mine is located on the Pennsylvania Railroad east of Bolivar (Bb 13). It is adjacent to the Bolivar No. 1 mine, through which mine the remaining coal was worked. The McFeeley mine was operated for a short time during 1920, with a daily output of 25 tons. The coal was used in the nearby brick plant, operated by the same company.

The coal bed is from 76½ to 80 inches thick, but it contains some relatively thick impure layers. The bed was measured and sampled at two points in the mine by U. S. Bureau of Mines in 1922. (See analyses, Table 7.)

Sections of Upper Freeport coal in McFeeley Brick "E" mine (Bb 13)

Section	A		B	
Laboratory No.	85579		85580	
	Ft.	*In.*	*Ft.*	*In.*
Roof, shale:				
Coal and sulphur		[a]2		[a]2
Coal	1	6	1	6
Bony streaked coal		[a]7		[a]10
Coal		11	3	3
Mother coal		¼		
Bony coal	..	.		[a]6
Coal	1	1		5
Mother coal		¼		..
Coal	1	5		..
Bony coal		[a]2		..
Coal		6		
Floor, fire clay:				
Thickness of bed	6	4½	6	8
Thickness of sample	5	5½	5	2

[a] Not included in sample
Section A was taken at face of 2 room, 2 right heading.
Section B was taken at face of 6 room, 2 right heading.
See analyses table.

Fairfield mine. This mine is south of Lockport on the west side of the Conemaugh River (Bb 25). According to reports it was opened as the Lockport mine by the Bolivar Coal Company in 1891. The Fairfield Coal and Coke Company completed mining the Upper Freeport here in 1928.

The mine had an average output of 300 tons per day; approximately 778,000 tons is the reported total production. The coal bed is from 52 to 60 inches thick, it contains impurities that are difficult to separate and the ash and sulphur content is high. Workings of this mine adjoin those of the Bolivar No. 1 mine at the north.

The coal bed dips to the south going below the river about 2000 feet from the pit mouth of the mine, and large reserves lie below drainage (Plate 9). An analysis of the Upper Freeport in this mine made by an unknown analyst is as follows: Moisture, 1.5 percent; volatile matter, 25.25 percent; fixed carbon, 64.25 percent; ash, 9.0 percent; sulphur, 1.6 percent; b.t.u. 14,100.

Climax mine. The Climax mine is located on the east side of the Conemaugh River opposite Lockport (Bb 24). According to reports, the mine was opened and operated by Bolivar Face Brick Company from 1911 to 1917, when mining was continued by Commonwealth Coal and Coke Co. to 1942. A total production of about 683,000 tons of Upper Freeport coal was reported. Approximately 188 acres have been mined out and lost, but a larger acreage adjacent to that area contains coal which is classified as measured coal (Plate 9). The coal bed is reported to have a normal thickness which ranges from 60 to 72 inches and a maximum local thickness up to 84 inches; reduction in thickness from the normal range is also reported. The coal bed is usually topped by from 8 to 10 inches of bony coal, and a persistent 3-inch binder occurs in the bed near the bottom; shale forms the immediate roof, and the cap rock is sandstone. An analysis of unknown origin is as follows: Moisture, 1.5 percent; volatile matter, 25.25 percent; fixed carbon, 64.25 percent; ash, 9.0 percent; sulphur, 1.6 percent; b.t.u. 14,100.

India mine. The India mine located just north of India (Bb 26) was started by Reese-Hammond Brick Company in 1900, and operated by J. Soisson Brick Company during 1918 and 1919. Its development covered about 22 acres and the reported production is a little over 49,000 tons. The Upper Freeport in this mine is said to be normally 48 inches thick. A considerable amount of coal remains for future development (Plate 9). Two analysis of the coal from the India mine made by unknown authority shows the following variations: Moisture, 1.5 to 2.0 percent; volatile matter, 24.3 to 25.25 percent; fixed carbon, 64.25 to 66.85 percent; ash 6.85 to 9.00 percent; sulphur 1.6 to 1.75 percent; b.t.u., 14,100 to 14,250.

Garfield no. 1 mine. Reports indicate that the Garfield no. 1 mine, which is on the hill northeast of Robinson (Bb 5), was operated by Garfield Smokeless Coal Company from 1918 to 1921 and produced about 117,000 tons of coal. Also reported is that the coal is from 72 to 96 inches thick, containing a 3-inch parting in the lower part. The bed is topped by 8 to 10 inches of bony coal, and is roofed by shale or sandstone. About 96 acres have been developed, but about 211 acres lying north of the developed area contain reserves classified as measured coal (Plate 9).

Indiana mine. Upper Freeport coal was mined in a small operation called the Indiana mine located on the hill northwest of Robinson (Bb 9). Reports concerning this mine are confusing, but it is indicated that it was opened by the J. Soisson Fire Brick Company and operated as the Elliott mine of the Elliott Coal Co. from 1918 to 1920, producing about 103,000 tons. The coal bed is reportedly similar to that in the Garfield no. 1 mine. Approximately 86 acres have been mined out and lost, but about 70 acres in the hill contain solid coal which is considered to be measured reserves (Plate 9).

Lawhead mine. This is a small custom pick mine which is excluded from State mining law. It is located northeast of Robinson (Bb 7). The mine was producing a small tonnage during the time of this survey, and about 7 acres have been developed. A section of the coal bed is as follows:

Section of Upper Freeport coal in Lawhead Mine (Bb 7)

	Ft.	*In.*
Cap rock, sandstone		
Roof, shale		
Bony coal	0	3
Coal	2	8½
Shale binder	0	1½
Coal	0	9
Floor, clay		
Thickness of coal section	3	8

Ellen mine. The Ellen mine is on the east branch of Richards Run, northeast of the Lawhead mine (Ba 46). It was active in 1945 and through 1950 and produced something above 64,000 tons of Upper Freeport. Indirect information indicates that the coal is "faulted" by the Mahoning sandstone at various places in the mine, causing difficult mining problems. A section of the coal bed measured a short distance in from the pit mouth is as follows:

Section of Upper Freeport coal in Ellen Mine (Ba 46)

	Ft.	*In.*
Cap rock, sandstone		
Roof, shale		
Bony coal	0	5
Coal	1	0
Shale binder	0	1
Coal	0	10½
Shale parting	0	3
Coal	1	1
Floor, clay		
Thickness of coal section	3	3½

About 35 acres had been developed when mining was discontinued. It is estimated that approximately 425 acres lying adjacent to the Ellen and Lawhead mines contains Upper Freeport coal classified as measured reserves. (Plate 9.)

Thompson no. 3 mine. A mine called Thompson no. 3 is located near the west branch of Richards Run and south of U. S. Route 22 (Ba 41). It was working in 1953 and up to and including that year, something over 98,000 tons were mined. The bed worked is called the Lower Freeport, but the physical character of the coal and its relative position with regard to the geologic structure, shows that it is the Upper Freeport. A typical section of the coal bed in the mine is as follows:

Section of Upper Freeport coal in Thompson No. 3 Mine (Ba 11)

	Ft.	*In.*
Cap rock, sandstone		
Roof, shale		
Bony coal	0	6
Coal	1	8
Shale binder	0	1
Coal	1	1
Thickness of coal section	2	10

The developed area of the mine covers about 19 acres, which is surrounded by about 236 acres classified as measured reserves (Plate 9).

Heshbon-Scottglen District

The Heshbon-Scottglen District includes northeastern West Wheatfield, northwestern East Wheatfield, southern Brush Valley and southwestern Buffington townships.

The Upper Freeport coal horizon crops out on the hillsides in the Valley of Blacklick Creek. From its thick development at Coral, the coal becomes thinner eastward to Claghorn; from Claghorn eastward the coal is thin or missing.

Vinton mines. The Vinton Colliery Company opened three drift mines on the Upper Freeport along Blacklick Creek in the vicinity of Claghorn (Ca 17, 19, 21) but these projects were short lived, apparently because of the reduced thickness, erratic nature, and inferior quality of the coal. It could not be determined for what reason these projects were initiated since core drilling in the immediate area had disclosed the habit of the Upper Freeport. But it may have been that the Upper Freeport was mistaken for the Lower Kittanning for the following reasons: The Lower Kittanning has been and still is a valuable producer in the area about Heshbon, Dias and Scottglen where it has undergone large scale commercial development. The Brush Valley syncline has forced the Lower Kittanning below Blacklick Creek just north of Heshbon, and it reappears above the stream bed on the rising limb of the syncline about 0.5 of a mile east of Claghorn (Plate 1). Also, the syncline has depressed the Upper Freeport toward the stream in the immediate vicinity of Claghorn; thus its relative position above drainage there is approximately comparable to the position of the Lower Kittanning with respect to drainage about Heshbon and Dias. It therefore would be expected that unfamiliarity with the structural features in the area concerned would understandably lead to mistaken identity of the Upper Freeport at Claghorn.

The Vinton no. 11 mine is on the north side of Blacklick Creek north of Claghorn (Ca 17). This mine was opened in 1917 and abandoned sometime after 1918, producing a little over 12,000 tons. The reported average thickness of the coal bed is 30 inches. A direct measurement of the coal was obtained where it was exposed in a small stripping near the pit mouth of the mine; the section is as follows:

Section of Upper Freeport coal in Vinton No. 11 Mine (Ca 11)

	Ft.	*In.*
Roof, shale		
Coal	1	5
Shale parting	0	2
Coal	0	10½
Thickness of coal section	2	5½

An area of about 8 acres was developed in the mine, and adjacent to the mined area there is about 68 acres classified as measured reserves in the thickness category of coal 28 to 42 inches. (Plate 9.)

The Vinton no. 12 mine is located on the north side of Blacklick Creek opposite Claghorn (Ca 19). This mine was worked contemporaneously with no. 11 mine, also developing about 8 acres and producing more than 12,000 tons; the average thickness of the coal is given as 30 inches. About 196 acres adjacent to the mined area is classified as containing measured reserves 28 to 42 inches thick.

Vinton no. 14 mine is a little south of Claghorn (Ca 21). Production from this mine is not known, but the mine survey map shows a development of about 4 acres. The bed thickness of the coal is reportedly 30 inches.

Heshbon area. Upper Freeport coal was strip-mined north of Heshbon for a distance of about 2,000 feet along the outcrop (Ba 11) by the Superior Coal Company. The following section was exposed.

Section of Upper Freeport coal in strip Mine at Heshbon (Ba 11)

	Ft.	*In.*
Cap rock, sandstone	15+	0
Roof, shale	10	0
Carbonaceous shale	0	8
Bony coal	0	5
Coal with streaks of sulphur and fusain	2	0
Shale parting	0	1½
Coal	0	11
Floor, shale		
Thickness of coal section	3	½

Two core drill holes were put down northwest of Heshbon (Ba 14, 15) revealing the following sections of the Upper Freeport Coal.

Section of Upper Freeport coal in core drill hole (Ba 14)

	Ft.	*In.*
Roof, shale		
Coal	3	0
Shale binder	0	4
Coal	0	4
Floor, clay		
Thickness of coal section	3	8

Section of Upper Freeport in core drill hole (Ba 15)

	Ft.	*In.*
Roof, shale		
Coal	3	8
Floor, clay		

The Upper Freeport was reported to be 30 inches thick in a caved country bank east of Heshbon School (Ba 9). Information about the Upper Freeport was unobtainable where the coal horizon crops out in the upland north of Heshbon School. A core drill hole northwest of Claghorn (Ba 7) found Upper Freeport represented by 20 inches of bony coal. Presence of the Upper Freeport south of Heshbon is based on indirect information. A shaft was dug for ventilation of the Heshbon no. 2 mine working Lower Freeport coal west of Ramsey Run (Ba 29) and the Upper Freeport was found to be 39 inches thick. Farmers reported Upper Freeport coal 30 to 36 inches thick in the hill west of Ramsey Run, but the coal is not exposed.

Area east of Claghorn and Heshbon. The horizon of the Upper Freeport crops out in the upland east from Claghorn and Heshbon to the boundary of the quadrangle. Outcrops of the coal were not found, nor was Upper Freeport of minable thickness reported to have been found. Numerous core drill holes have penetrated the coal horizon in this area, and invariably it was found that the Upper Freeport was marked by a few inches of carbonaceous material or its place was filled with fine sedimentary rocks indicating water conditions too deep for growth of vegetation (See core drill sections, Plate 2, Sections 17, 18; Plate 3, Sections 7-16).

New Florence-Seward District

The horizon of the Upper Freeport coal is deeply buried throughout most of the New Florence-Seward district. It crops out in the Valley of the Conemaugh River from Boltz at the east boundary of the quadrangle southwestward to within about 1 mile north of New Florence. Exposures are poor and nowhere was the coal explored. As evidenced by numerous core test holes which were drilled to the Lower Kittanning coal in the district north of the Conemaugh River (Plate 2, Sections 20-23; Plate 3, Sections 17-30; Plate 4, Sections 1-25) the Upper Freeport coal is thin or missing in this area. The horizon of the Upper Freeport crops out in the foot hills of Laurel Hill east and south of New Florence, and indications are that the coal is either thin or missing to near Tubmill Reservoir.

Southeast District

The Upper Freeport coal is well developed and probably continuous where it crops out from Tubmill Reservoir to a position a little southwest of Mellons. A caved country bank is located on the hill east of Tubmill Reservoir (Cc 1) and a resident in the vicinity said the bed is 48 inches thick, containing a binder near the bottom. A strong "Bloom" of the coal was seen on the township road northwest of the reservoir. An earlier geologic report (Stevenson, 1877, p. 166) shows that the Upper Freeport was opened in the early 1870's on Tubmill Creek south of the reservoir (Bc 5) and is there 60 inches thick. Upper Freeport was mined in a custom bank in 1949 southwest of Mellons (Bc 24), where the coal bed is from 40 to 60 inches thick and is nearly free from visible impurities. It is topped by 3 to 4 inches of bony coal, roofed by shale which is capped by massive Mahoning sandstone. The area of development in the mine could not be determined.

Information about the Upper Freeport is lacking from the above location to the southern boundary of the quadrangle. Its probable continuity as a minable bed is indicated by its presence in a country bank in the Somerset quadrangle a little south of Kissel Springs where the following section was measured.

Section of Upper Freeport coal south of Kissel Springs

	Ft.	*In.*
Roof, shale		
Coal	0	10
Shale parting	0	¼
Bony coal	0	1½
Coal	0	4½
Floor, clay		
Thickness of coal section	1	4½

An analysis of a channel sample of the coal, including impurities and made by reputable analysts, is as follows: Moisture, .93 percent; volatile matter, 23.68 percent; fixed carbon, 59.65 percent; ash, 15.74 percent; sulphur, 3.52 percent; b.t.u. 12,862.

The horizon of the Upper Freeport crops out on the east slope of Laurel Hill in the southeastern part of the New Florence quadrangle, underlying about 1,397 acres. The area north of Allwine Run in part, has been tested by core drill holes (Plate 2, Sections 24, 25; Plate 4, Sections 24-29) showing that the coal is thin or wanting. So far as could be determined, the coal bed has not been explored in the quadrangle south of the run and outcrops are concealed. Some minable Upper Freeport may be present near the southern boundary of the quadrangle. A test pit was dug just south of the southern boundary along the road which traverses the foot hills of the mountain east of Riffle Run; the coal section is as follows: cap rock, sandstone; roof, shale, coal 48 inches with minor visible impurities.

Lower Freeport Coal

General account. The Lower Freeport "D" coal takes its name from the town of Freeport along the Allegheny River. This coal bed is an important producer in many of the bituminous districts of Pennsylvania, and has a variety of designations. It is the famous "Moshannon" coal in the Moshannon basin of Center and Clearfield counties, the "Big Bed" in the Karthaus region, the "M" coal in Elk County, the "Limestone" coal in Cambria county, and the "Reynolds Gas" coal in the Reynolds basin in Jefferson County.

The Lower Freeport lies at an average depth of 40 feet below the Upper Freeport in the New Florence quadrangle. As determined from available information, the coal has fair distribution in the region north of the Conemaugh River but it is generally too thin to have present economic value in most of that region. The coal has attained a relatively thick and persistent development in northern West Wheatfield and northwestern East Wheatfield townships where it presently (1953) is being deep-mined in a large scale commercial operation. Some Lower Freeport coal has also been strip-mined. Large tonnages of coal are available for development.

Approximately 2,300 acres contain reserves classified as measured coal over 28 inches thick (Plate 10).

Heshbon-Scottglen District

Heshbon no. 2 mine. The Heshbon no. 2 mine is on Ramsey Run south of Heshbon (Ba 28). According to production reports the mine opened in 1936 and up to and including 1951, produced 1,740,000 tons of Lower Freeport coal. Development in the mine covers about 330 acres and approximately 700 additional acres are available for development. The coal bed ranges from 32 to 60 inches thick; the average thickness is 48 inches. A persistent parting occurs in the upper part of the bed, and at some places in the mine an additional parting is also present in the middle part of the bed. A typical bed section is as follows:

Section of Lower Freeport coal in Heshbon No. 2 mine (Ba 28)

	Ft.	*In.*
Roof, shale		
Bony coal	0	5
Coal	1	1
Shale parting	0	3
Coal	3	8
Floor, clay		
Thickness of coal section	5	0

Analysis of the Lower Freeport as shipped and delivered from this mine is shown on Table 8.

East of Heshbon. The horizon of the Lower Freeport crops out on the valley sides along Blacklick Creek east of Heshbon. The area south of Blacklick Creek lying between Heshbon and Shellbark School has been tested by core drill holes, and on the basis of these test holes it is estimated that measured reserves of coal over 28 inches thick underlie more than 1,000 acres (Plate 10). The bed thickness ranges from 37 to 45 inches including a 1- to 2-inch binder or parting in the lower part. (Plate 2, section 18; Plate 3, Sections 7, 12-16.) A typical bed section is as follows:

Section of Lower Freeport coal east of Heshbon

	Ft.	*In.*
Roof, shale		
Coal	2	1
Shale parting	0	1½
Coal	1	5
Floor, clay		
Thickness of coal section	3	7½

An inacessible country bank on the Lower Freeport is located northeast of Shellbark School (Ca 41). In a caved and abandoned country bank of Marldis Run north of Armagh (Ca 49) the coal is reportedly 30 inches thick.

North of Blacklick Creek. Information about the Lower Freeport in the area north of Blacklick Creek is from scattered core drill holes (Plate 3, Sections 2-5, 8-11) which indicate that the coal is generally missing or is represented by a few inches of bony coal.

Chestnut Ridge. The Lower Freeport has a fair development on Chestnut Ridge south of Blacklick Creek. It crops out on the flanks and is preserved on the top of the ridge north of U. S. Route 22 as an irregularly-shaped erosional remnant. Apparently not much deep mining has been done on the coal in this area, but a considerable amount has been strip-mined; there still is some strippable coal remaining (Plate 10). The area contains approximately 600 acres which is classified as measured reserves. Measurements obtained in strip mines show a bed thickness varying from 24 to 44 inches, with one or two binders or partings in the lower part. Shale normally overlies the coal but its place is occupied by sandstone locally. Following are sections obtained in strip mines:

Sections of Lower Freeport coal in strip mines

(Ba 26)

	Ft.	*In.*
Roof, shale		
Bony coal	1	0
Coal	1	1
Shale binder	0	1½
Coal	1	6
Thickness of coal section	3	8½

(Ba 24)

	Ft.	*In.*
Roof, shale		
Bony coal	0	4
Coal	0	10
Bony coal	0	2
Shale binder	0	1
Coal	0	10
Shale binder	0	1½
Coal	0	3½
Shale parting	0	½
Coal	0	8
Thickness of coal section	3	½

(Ba 23)

	Ft.	*In.*
Roof, shaly sandstone		
Shale	0	4
Bony coal	0	3
Coal	1	2
Shale binder	0	1
Coal	0	9
Shale binder	0	1½
Coal	0	9
Floor, clay		
Thickness of coal section	2	4½

(Ba 37)

	Ft.	*In.*
Roof, shale		
Bony coal	0	3
Coal	1	1
Shale binder	0	½
Coal	0	9
Shale binder	0	1
Coal	0	7
Floor, clay		
Thickness of coal section	2	6½

A small operation called the William Penn mine was working the Lower Freeport on U. S. Route 22 near Ridge School (Ba 38). The coal bed ranges from 36 to 42 inches thick; it is topped by 3 inches of bony coal and has a 3 inch binder 8 to 10 inches from the bottom; the roof is shale. The Lower Freeport was exposed in a small stripping along Weiers Run on the west side of Chestnut Ridge (Aa 43) and the following section was obtained:

Section of Lower Freeport coal in strip mine on Weiers Run (Aa 43)

	Ft.	*In.*
Roof, shale		
Coal	0	5½
Bony coal	0	2½
Coal	1	7
Floor, clay		
Thickness of coal section	2	3

Blacklick area. A few core drill holes have penetrated the Lower Freeport in the Blacklick area where the coal is well below the surface, and the "cores" indicate that the bed is extremely variable in thickness. The core sections are shown on (Plate 2, Sections 1, 3, 6, 7, 11. 12; Plate 3, Section 1; Plate 4, Section 37).

Little information on the Lower Freeport was obtainable in the Bolivar district, but indications are that this coal generally does not constitute a mineral resource at the present, but it does have a relatively thick local development.

Climax no. 3 mine. Some Lower Freeport was produced currently with the operations on the Upper Freeport in the Climax no. 1 and 2 mines at Lockport (Bb 24) during 1919 through 1923, and the reported production of Lower Freeport is about 68,000 tons. It was reported that the normal bed thickness is 42 inches; it also was reported that the respective coal beds come together in the mines. The areal extent of the mine on the Lower Freeport could not be determined, and the continuity of the bed in the surrounding area is not known to have been explored by core drilling, but reserves of this coal may be present in some quantity. A section of the Lower Freeport was measured a short distance in from the pit mouth of the mine. It is as follows:

Section of Lower Freeport coal in Climax Mine (Bb 24)

	Ft.	*In.*
Roof, shale		
Coal	0	5½
Shale parting	0	¼
Coal	0	8½
Shale parting	0	½
Coal	0	11
Shale parting	0	1½
Coal	1	5
Floor, clay		
Thickness of coal section	2	10¼

Two analyses of unknown authority show the following variations:

Analyses of Lower Freeport coal in Climax mine

	Percent
Moisture	1.50- 2.00
Volatile matter	24.3 -25.25
Fixed Carbon	64.25-66.85
Ash	6.85- 9.0
Sulphur	1.6 - 1.75
B.t.u.	14,000—14,250

A small quantity of Lower Freeport was strip-mined near the Garfield No. 1 mine at Robinson (Bb 5). The coal was concealed, but the information obtained locally indicates a thickness from 24 to 25 inches. Some Lower Freeport was mined with its underlying limestone in a drift along Richards Run north of Robinson (Bb 6); the workings could not be entered. The Lower Freeport coal is 24 inches thick where it was mined with the accompanying limestone farther north along the west branch of Richards Run (Ba 45). A thickness of 30 inches for the Lower Freeport was reported in the hill farther to the north (Ba 42).

The relatively dense distribution of core drill holes in the area north of New Florence and Seward and extending to U. S. Route 22 has disclosed that the Lower Freeport coal is either thin or missing, or is a minor local development (Plate 2, Sections 20-23; Plate 3, Sections 17-30; Plate 4, Sections 2-23).

Nothing was learned about the Lower Freeport in the Ligonier Valley south of the Conemaugh River. Core drill holes on the east side of Laurel Hill at the southeast indicate that the Lower Freeport is generally missing, and where present, the coal bed is impure (Plate 2, sections 24, 25; Plate 4, sections 24-29).

Upper Kittanning Coal

The Upper Kittanning C′ coal is known in the region about Johnstown as the "cement" coal because of its association with the underlying limestone, called the Johnstown cement rock. The Upper Kittanning has some economic importance in the Johnstown quadrangle, and it is also important in other parts of the bituminous fields, but where data on this coal were obtained in the New Florence quadrangle it generally is poorly developed or missing (Plates 1, 2, 3). The thinner bedded Upper Kittanning, or up to about 24 inches thick, is apparently free from visible impurities but as the bed thickness increases, partings also are proportionally thicker, and locally the coal and included impurities occur in approximately equal amounts (Plate 3, section 1; Plate 4, section 37).

The only known locality in the quadrangle which holds promise of containing Upper Kittanning of economic interest at present, is at the extreme southeast corner of the quadrangle where the coal crops out in the foot hills of Laurel Hill. In the Johnstown quadrangle to the east (Phalen 1911), and in the Somerset quadrangle to the south (Richardson 1934), the Upper Kittanning has a minable and persistent thickness. On the basis of core test holes drilled in this part of the New Florence quadrangle and immediately in the adjoining Johnstown quadrangle, minable Upper Kittanning probably extends into the New Florence area (Plate 2, sections 24, 25; Plate 4, sections 24-29). The cores of the Upper Kittanning show a thickness ranging from 30 to 64 inches and, consistent with its habit described above, expanded bed sections contain thicker partings.

The Upper Kittanning was mined in a country bank on Bens Run near the east boundary of the quadrangle (Cc 12). Caving blocked the entry and information about the coal could not be obtained. A strong "bloom" of the Upper Kittanning shows on the township road to the west (Cc 11).

Lower Kittanning ("B") Rider Coal

The correlation of the "B" rider coal is discussed in the foregoing section headed Allegheny Series. Although the "B" rider is a relatively thin coal bed (18 to 30 inches thick) and considered not to have much present economic value, it merits some discussion as a possible future reserve.

Subsurface data in the New Florence-Seward district north of the Conemaugh River to U. S. Route 22 (Plate 2, sections 20-23; Plate 3, sections 17-29; Plate 4, sections 2-23) and direct observation south of Seward, formed the basis for an estimate of 5,500 acres underlain by an apparently continuous deposit of "B" Rider coal from 18 to 30 inches thick. This coal lies normally 25 feet above the Lower Kittanning and is logged as a solid bed of presumably clean coal, but it is occasionally shown containing a 1-inch parting at about the middle of the bed.

The "B" rider is 24 inches thick in the high wall of a strip mine on the Lower Kittanning south of Seward (Cb 10). The coal shows the following section where it was stripped east of New Florence (Cb 17):

Section of Lower Kittanning rider coal in strip mine east of New Florence (Cb 17)

	Ft.	*In.*
Roof, shale		
Coal	0	2½
Shale parting	0	3
Coal	2	
Thickness of coal section	2	5½

A caved drift in this coal is on Powdermill Run to the south (Cb 18). The "B" rider was mined with its underlying limestone on Baldwin Run south of New Florence (Cb 19). Caving blocked the entry and the following section was furnished by a former owner of the mine.

Section of Lower Kittanning rider coal in mine south of New Florence (Cb 19)

	Ft.	*In.*
Roof, sandstone		
Bony coal	0	5
Coal	2	5
Floor, clay		
Thickness of coal section	2	5

Core drilling in the Heshbon district shows that the "B" rider coal is very thin or missing. The bed appears to have some continuity in the area between Dias and Scottglen where the following sections were obtained in the high walls of strip mines on the Lower Kittanning coal.

Sections of Lower Kittanning rider coal in strip mines

(Ca 36)

	Ft.	In.
Roof, shale or sandstone		
Coal	0	7
Shale parting	0	1
Coal	0	7
Shale parting	0	4
Coal	0	10
Floor, shale		
Thickness of coal section	2	5

(Ca 9)

	Ft.	In.
Roof, shale		
Coal	0	8
Shale binder	0	1¾
Coal	0	10
Floor, shale		
Thickness of coal section	1	7¾

Lower Kittanning ("B") Coal

General Account. From the standpoint of continuity and distribution, the Lower Kittanning probably is the most valuable coal bed of the Allegheny Series in the Pennsylvania bituminous fields. Since the depletion of the Pittsburgh coal in the New Florence quadrangle the Lower Kittanning is definitely the most important coal in this area. It is the valuable Miller coal in Cambria County.

Commercial deep mining of the Lower Kittanning began in the quadrangle in the early part of this century, and a reported total of about 24 million tons has been produced up to and including 1952 by deep mines; and unknown tonnage has been produced in strip mines. At one time, 16 commercial mines were producing Lower Kittanning coal in the quadrangle, only four large mines were active when this survey was made. Approximately 6,630 acres have been developed by deep mining. It is estimated that there are approximately 21,230 acres, containing something over 111 million tons of reserves, classified as measured coal, 28 inches and more thick (Plate 11). The outcrop line of the Lower Kittanning in the areas of this class of reserves totals about 447 miles, of which only about 4 miles have been strip-mined.

The Lower Kittanning has a normal thickness ranging from 36 to 48 inches. One or more shale or bone partings and binders are usually present, as is pyrite (sulphur) in lenses and balls, but this latter impurity is easily cleaned from the coal in the mine. Lenses of fusain are not uncommon. Shale generally is the roof material, but sandstone tops the coal in some localities and it "rolls" into and through the coal bed in some mines.

Analyses of mine samples of coal as shipped and delivered are shown on Tables 7, 8.

The Lower Kittanning coal is low-volatile bituminous rank in the New Florence-Seward district; elsewhere in the quadrangle it is medium-volatile bituminous rank (Plate 11). According to authoritative sources, the Lower Kittanning is a good steam coal in this area. The low volatile coal must be blended with higher volatile coals to avoid excessive swelling in coking.

The physical characteristics, distribution and exploitation of the Lower Kittanning are described below with respect to districts similar to the preceding description of the Upper Freeport Coal.

Blacklick-Strangford District

Bells Mill mine. The Bells Mill mine is on the Pennsylvania Railroad east of Josephine (Aa 9), where the Lower Kittanning coal emerges from Blacklick Creek rising eastward into the upland on the Chestnut Ridge anticline. The mine was started in 1905 by the Bells Mill Coal Company, and was worked successively by the Graff Coal Company and the Westmoreland Mining Company until abandoned in 1937; the reported production was something over 1,200,000 tons. Approximately 352 acres have been mined out and lost. It is estimated that about 500 acres contain measured coal below drainage west of the mine and about 900 acres contain measured coal above drainage north and east of the mine (Plate 11).

The normal thickness of the Lower Kittanning coal in the Bells Mill mine is from 43½ to 45½ inches; visible sulphur is present in variable amounts. A few inches of bony tops the coal; the roof is shale and the cap rock is sandstone. The coal bed was measured and sampled at three points in the mine by U. S. Bureau of Mines in 1922 (see analyses Tables 7, 8).

Sections of Lower Kittanning coal in Bells Mill mine (Aa 9)

Section	A		B		C	
Laboratory No.	85502		85503		85504	
	Ft.	*In.*	*Ft.*	*In.*	*Ft.*	*In.*
Roof, shale						
Bony coal		[a]5		[a]5		[a]6
Coal	3	3	1	10	3	3½
Sulphur				[a]½		
Coal			1	4		
Floor, shale						
Thickness of bed	3	8	3	7½	3	9½
Thickness of sample	3	3	3	2	3	3½

[a] Not included in sample

Section A was taken at face of main flat entry, 5,000 feet from the mine mouth. Section B was taken at face of 10 right butt heading, main dip heading. Section C was taken at face of main dip heading.

Jewell no. 3 mine. Records indicate that the Jewell no. 3 mine which is on the south side of Blacklick Creek opposite the Bells Mill mine (Aa 11) was operated by the Smith Coal Company from 1919 to when it was abandoned in 1931; the total output of Lower Kittanning coal as reported is 513,000 tons. The character of the coal in this mine is similar to that in the Bells Mill mine. Approximately 208 acres have been mined and lost. About 150 acres of measured coal is available north of the mined area and a very large area, underlain by measured reserves, lies south and west (Plate 11).

Latrobe syncline. Subsurface information on the Lower Kittanning coal where it lies deeply buried in the Latrobe syncline is meager. Only five core drill holes have penetrated this coal and they indicate thinning from its relatively thick development in the mines on Blacklick Creek. A hole north of Blacklick (Aa 13) found only 20 inches of Lower Kittanning coal; two holes south of Blacklick revealed thicknesses of (Aa 27) 37 inches and (Aa 24) 36 inches; in another hole still farther south (Aa 47) the coal is 32½ inches thick; and a hole east of Smith near the center of the syncline (Aa 36) found 36 inches of Lower Kittanning coal (see detailed sections, Plate 2, sections 3, 6, 11, 12; Plate 4, section 1).

Considering the generally persistent habit of the Lower Kittanning where it has been explored elsewhere, it would be reasonable to expect that adequate core drilling probably would disclose large reserves of this coal in the Latrobe syncline. The extreme reduction of thickness of 20 inches in the one hole may be only a minor local thinning of the bed which is known to occur even in areas of maximum thickness.

Chestnut Ridge anticline. Little information about the Lower Kittanning coal was obtained where it crops out on Chestnut Ridge anticline north of the Conemaugh River, but indications are that it is present and probably is a minable bed.

The Lower Kittanning is 42 inches thick and covered by shale where the coal was opened in a trench at the axis of the anticline, near the northern boundary of the quadrangle (Ba 2). A country bank, now caved, is 1.2 miles to the east (Ba 5). The farmer who worked the coal said it is 46 inches thick, contains only minor impurities, is topped by bony coal and roofed by shale.

The Lower Kittanning crops out on the ridge south of Blacklick Creek to U. S. Route 22, but the outcrop is concealed. A caved country bank in the coal is near the crest of the ridge south of the highway (Ba 43) but information about the bed was not to be had. A coal identified as the Lower Kittanning was mined out of the knob east of Reisinger School (Ba 44) and it is claimed to be 36 inches thick. Nothing was learned about the Lower Kittanning coal where it crops out on the sides of Chestnut Ridge southwest to the boundary of the quadrangle.

Torrance. The Lower Kittanning coal is exposed in a cut on the Pennsylvania Railroad east of Torrance. It is there 41 inches thick but contains numerous impurities which render it poor in quality.

An abandoned country bank on the Lower Kittanning coal is located southeast of Grays (Ab 7).

Bolivar-Robinson District

The outcrop of the Lower Kittanning coal rises above the Conemaugh River at Lockport. It follows the south bank of the river to Bolivar. On the north side of the River the crop line extends a short distance up Richards Run and follows along the unnamed run north from Robinson to near U. S. Route 22.

Garfield mines. The Garfield mines are operated by the Garfield Smokeless Coal Company. Garfield no. 2 mine is just north of Robinson (B 68). It was active from 1919 through 1940, and mined about 734,000 tons of Lower Kittanning coal. Approximately 350 acres have been developed in this operation, and approximately 1,190 acres of measured reserves is estimated to lie north and east of the mined area (Plate 11). The normal thickness of the bed is from 36 to 48 inches; an additional 16 to 24 inches of impure "bottom" coal was not taken. A variable thickness of bony tops the coal which is roofed by shale. Analyses of the coal as shipped and delivered from this mine are given on Table 8.

Garfield No. 3 mine is about 0.5 mile north of Robinson. The first opening (Bb 3) was made in 1919. This operation was discontinued in 1923 and the production is reported to have been 108,000 tons. Another heading was driven a short distance to the north (Bb 2) in 1943. The mine was still working in 1951 and the total reported tonnage is 374,000 tons. The physical character of the coal is similar to that in the no. 2 mine. A typical section of the coal bed is as follows:

Section of Lower Kittanning coal in Garfield No. 3 mine (Bb 2)

	Ft.	*In.*
Roof, shale		
Bony coal	0	7
Coal	3	5
Shale	0	2
Clay	1	4
Coal	1	5
Floor, clay		
Thickness of coal section	6	11

Abandoned entries on the Lower Kittanning are at the end of the hill south from the Garfield no. 3 mine (Bb 10) which reportedly is the Elliott mine opened in 1920 and abandoned in 1924. Mining was resumed in 1929 and continued until final abandonment in 1933. The total production is reported to be about 92,000 tons.

The area developed by Garfield no. 3 and Elliott mines is approximately 441 acres. About 96 acres north of the Garfield no. 3 mine contains reserves classified as measured coal. (Plate 11.)

McFeeley Brick ("B") mine. The McFeeley Brick "B" mine is a slope mine along the Pennsylvania Railroad east of Bolivar (Bb 14). Records indicate that production from this mine began in 1922 and continued up to 1928, producing about 30,000 tons of coal which was consumed in the brick plant. The coal ranges from 41 to 41½ inches thick. It was measured and sampled in 1922 at two points in the mine by U. S. Bureau of Mines in 1922; following are the sections.

Sections of Lower Kittanning coal in McFeeley Brick "B" mine (Bb 14)

Section	A		B	
Laboratory No.	85576		85577	
	Ft.	*In.*	*Ft.*	*In.*
Roof, shale				
Bony coal		[a]6		[a]6
Coal	2	11	1	0
Sulphur				[a]½
Coal			1	11
Floor, fire clay:				
Thickness of bed	3	5	3	5½
Thickness of sample	2	11	2	11

[a] Not included in sample

Section A was taken at face of 7 room, main heading, 700 feet southwest of mine mouth. Section B was taken at face of 3 right heading, main heading, 700 feet west of mine mouth.

The Lower Kittanning coal was exposed in a trench north of Lockport (Bb 23) and the following section was obtained.

Section of Lower Kittanning coal north of Lockport (Bb 23)

	Ft.	*In.*
Roof, shale		
Bony coal	1	2
Coal, with sulphur streaks	3	0
Bony coal	0	8
Coal	1	6
Floor, clay		
Thickness of coal section	5	2

Lower Kittanning coal 36 inches thick is reported in a caved country bank just west of Bolivar (Bb 16).

Heshbon-Scottglen District

The outcrop of the Lower Kittanning coal follows along the sides and extends up the tributary streams of the Blacklick Creek in the Heshbon-Scottglen district. The coal has been mined in numerous major operations, but only one large scale mine was active in 1952. It is estimated that approximately 2,712 acres have been mined out and lost, and it is also estimated that the district contains approximately 7,450 acres of measured reserves of Lower Kittanning 28 inches and more thick (Plate 11). The Blacklick Branch of the Pennsylvania Railroad runs through the Valley of Blacklick Creek.

Virginian no. 14 mine. The original entry to the Virginian no. 14 mine is located on the north side of Blacklick Creek, west of Heshbon (Ba 17). The mine was opened in 1929 and was successively operated by Standard Bituminous Coal Company, Globe Coal Company, and Franklin Coal Company until 1940 when the L. C. S. Collieries Company acquired the mine and drove a new entry on Aulds Run to the east of the original entry

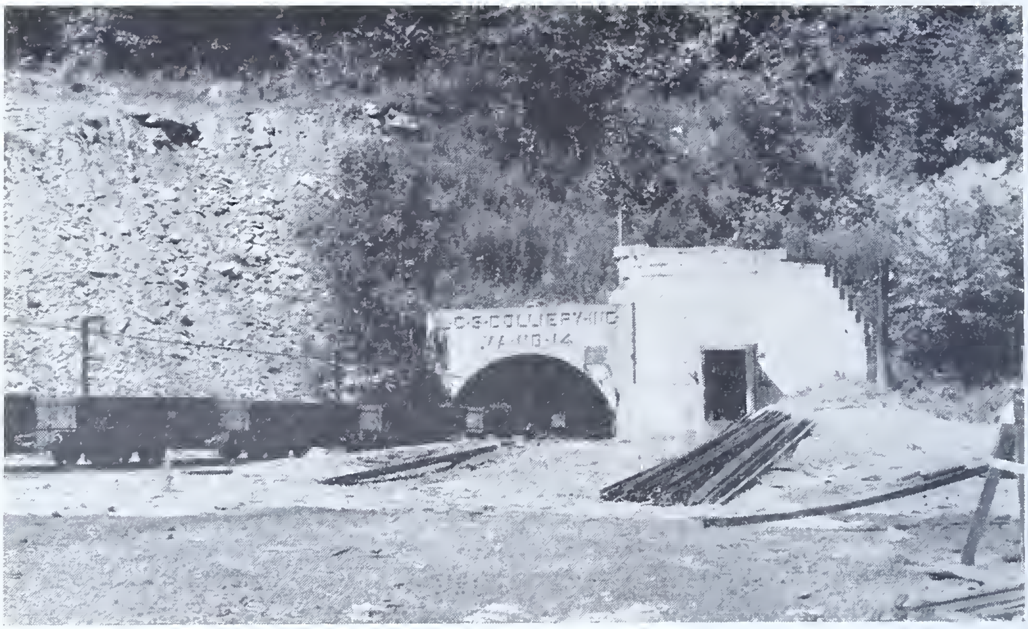


Figure 10. Entry to L.C.S. Colliery mine, west of Heshbon.

(Ba 16). The workings at the Virginian no. 14 mine in the New Florence quadrangle cover about 862 acres. The total output of the mine up to and including 1952 is 1,876,000 tons.

The coal bed is normally 40 inches thick; reduced or expanded thicknesses occur locally. Thin partings and sulphur binders are common constituents; the bed may be topped by a few inches of bony or the roof shale may be in contact with the coal. Analyses of run-of-mine coal are given on Table 8.

Caldwell no. 2 and Superior no. 1 mines. Caldwell no. 2 mine on the north side of Blacklick Creek, northeast of Heshbon (Ba 12) was originally worked by the Caldwell Smokeless Coal Company from 1917 to 1921, producing about 37,000 tons. Historical data on this mine between 1921 to 1941 is not clear, but in 1941 the mine was obtained by the Superior Coal Company, and was operated as the Superior no. 1 mine from a new opening (Ba 13) until mining operations were suspended in 1951. During this time something over 229,000 tons of coal was produced.

An average thickness of 36 inches is given, but the coal is very variable. Sandstone, which is the cap rock in this locality, "rolls" into the coal at various places in the mine, and operations were suspended when this difficulty was encountered. About 83 acres have been mined and lost.

An abandoned and caved entry on the Lower Kittanning is just east of Heshbon on the south side of Blacklick Creek (Ba 18). Information concerning this apparently small mine could not be obtained. Strong "blooms" mark the outcrop of this coal south (Ba 20) and southwest of Heshbon (Ba 25). Core drill holes north of Heshbon show the variable character at the Lower Kittanning in that locality. (Plate 3, sections 2, 3, 4, 5.)

Continuity and character of the Lower Kittanning coal in the area south of Blacklick Creek, east from Heshbon to Pa. Route 56 is revealed in core drill holes. (Plate 2, section 18; Plate 3, sections 6, 7, 12-16.) The test holes in this area show that the Lower Kittanning coal is variable in thickness and is locally missing.

Vinton no. 16 mine. The Vinton Collieries Company no. 16 mine is west of Dias on the north side of Blacklick Creek (Ca 14). An area of approximately 140 acres has been developed in this mine and from 1918, when production started, to 1923 when operations ceased, about 286,000 tons were produced. The Lower Kittanning coal ranged from 26 to 43 inches and averaged about 36 inches thick. Large reserves are available to the north and west of this mine (Plate 11). Some strip coal was produced east of the mine entry.

Virginian no. 15 mine. The Virginian no. 15 mine is located north of Dias (Ca 12). Production from this mine is reported to have been initiated in 1919 by Standard Bituminous Coal Company; it was known as the Buena Vista mine from 1928 to 1932 when production no longer was reported. The mines total output is about 584,000 tons; approximately 115 acres have been developed. A thickness range of from 36 to 46 inches is indicated for the Lower Kittanning Coal. Analyses of run-of-mine coal are given on Table 8.

Vinton no. 17 mine. Vinton no. 17 mine operated by the Vinton Collieries Company, is on the south side of Blacklick Creek west of Dias (Ca 15). This mine was opened in 1920 and abandoned in 1921, producing about 133,000 tons. Why this project was discontinued is not known. The mine survey map indicates that the coal bed ranges from 30 to 40 inches in thickness. Impurities in the coal are not indicated.

Hutzel mine. This is a small mine located on Pa. Route 56 south of Dias (Ca 27). It has an output of 130 tons per day and 4 acres have been mined (1951). The mine operator said that at least 2,000 acres of virgin coal is adjacent to his mine. The Lower Kittanning in this mine is generally 48 inches thick and contains sulphur in lenses and scattered particles. Analyses of run-of-mine coal show an average of 10 percent ash and 4 percent sulphur. Some coal was strip-mined just north of the mine entry.

Caldwell no. 1 mine. The Caldwell no. 1 mine which was operated by the Caldwell Smokeless Coal Company, is east of Dias on the north side of Blacklick Creek (Ca 30). Mining on the Lower Kittanning was started in 1917 and stopped in 1930, producing 247,000 tons; an area of about 70 acres was developed. The coal bed is 46 inches thick. A considerable quantity of coal was strip-mined to the north of the Caldwell no. 1 mine where the following sections of the Lower Kittanning coal were measured: (Ca 30) shaly sandstone and shale, 25 feet; coal with streaks of sulphur, 48 inches; (Ca 29) shale, 25 feet; coal with lenses of sulphur 43 inches; (Ca 9) shale, 20 feet; coal with lenses of sulphur 48 inches.

Thermal no. 15 mine. The Thermal no. 15 mine located east of Scottglen (Ca 34) was opened in 1915 and operated successively by Dilltown Smokeless Coal Company, Toash Coal Company, Lennox Coal Company and Cosgrove-Meehan Coal Company. Mining was discontinued in 1938, and the total reported output is approximately 3 million tons. About 480 acres of the mined area lies in the New Florence quadrangle, and large reserves of Lower Kittanning lie adjacent to the worked area (Plate 11). The coal bed is from 29 to 41 inches thick. The bed was measured and sampled at three points in the mine by U. S. Bureau of Mines in 1922; following are the sections. (See analyses Table 8.)

Sections of Lower Kittanning coal in Thermal No. 15 mine (Ca 34)

Section	A		B		C	
Laboratory No.	85061		85062		85063	
Roof, Slate:	*Ft.*	*In.*	*Ft.*	*In.*	*Ft.*	*In.*
Coal	2	0	1	9	2	1½
Slate		[a]¼		[a]⅛		[a]¼
Coal		5		4½	1	4
Slate				[a]¼		
Coal				10		
Floor, slate						
Thickness of bed	2	5¼	2	⅞	3	5¾
Thickness of sample	2	5	2	½	3	5½

[a] Not included in sample

Section A was taken at face of 5 left A entry. Section B was taken at face of main heading. Section C was taken at face of 1 room, F heading, 1 left heading.

West of Scottglen, the Lower Kittanning was strip-mined for a linear distance of about 6,000 feet (Ca 33). The coal maintains a uniform thickness which varies little from 47 inches; numerous lenses of sulphur are in the bed. The highwall in the stripping is up to about 30 feet and the material is largely composed of shale.

Amerford mine. The Amerford mine is south of Scottglen (Ca 35). It was operated continuously from 1913 to 1927, producing about 1,017,000 tons. The Lower Kittanning in this mine is from 42 to 48 inches thick. A measurement of the coal bed obtained in a stripping west of the abandoned pit mouth (Ca 36) is as follows: Cover, shale; coal, 48 inches, contains lenses of sulphur; clay.

Brush Valley mine. The Brush Valley mine is southwest of Scottglen (Ca 50). It was operated by the Kiski Coal Company from 1905 to 1928 when the mine was abandoned. The total reported output is 1,511,000 tons. Workings in this mine were advanced southwest to beyond Armagh. The combined worked areas of the Brush Valley and Amerford mines is 960 acres. A very large area containing reserves classified as measured coal, lies adjacent to these mined areas. (Plate 11.) The bed thickness is from 43 to 50 inches and it contains numerous sulphur binders. The coal bed was sampled and measured at five points in the mine by U. S. Bureau of Mines in 1915, following are the sections: (see analyses Table 7.)

Sections of Lower Kittanning coal in Brush Valley mine (Ca 50)

Section	A		B		C		D		E	
Laboratory No.	22501		22502		22503		22504		22505	
Roof, shale:	*Ft.*	*In.*	*Ft.*	*In.*	*Ft.*	*In.*	*Ft.*	*In.*	*Ft.*	*In.*
Coal, bony										a¾
Coal		6		5		4		½		5½
Sulphur		a½		a1/16				a¼		a¼
Coal		½						4¾		
Sulphur		a½				a1		⅛		
Coal		3								
Sulphur		a⅛								
Coal		3								
Sulphur		¼								
Coal		1				8½		8		7
Sulphur		⅛								
Coal binder						⅝		¾		¾
Coal		5		11½				3¼		
Sulphur		⅛		a⅜				¼		
Coal		11	1	1	1	3	1	2	1	4½
Sulphur		a¼		⅛		a⅞		⅛		a⅜
Coal	1	2	1	4	1	7¼	1	½	1	1
Sulphur and coal .										a6
Floor, shale, bottom coal, and clay										
Thickness of bed .	3	9⅜	3	10 1/16	4	1¼	3	8½	4	2⅛
Thickness of sample	3	8⅛	3	10 1/16	3	11⅜	3	8½	3	7

[a] Not included in sample.

Sample A was measured at face of 6 right entry, 4,450 feet S. 75° W. of drift mouth. Sample B was measured on pillar in 36 room, 280 feet off 7 right heading and 3,300 feet S. 65° W. of drift mouth. Sample C was measured at face of 8 right back entry, 3,400 S. 55° W. of drift mouth. Sample D was measured in 11 right back entry, 10 feet off main entry, 3,675 feet S. 30° W. of drift mouth. Sample E was measured in face of butt back entry, 5 left entry, 2,025 feet S. 10° W. of drift mouth.

Thompson no. 1 mine. The Thompson no. 1 mine is a small custom operation on Marldis Run north of Armagh (Ca 40) having a daily output of 30 tons. This mine is advancing into the workings of the Amerford mine. The coal bed averages 46 inches thick, contains considerable sulphur, and is roofed by shale.

New Florence-Seward District

The Lower Kittanning has been and is still mined extensively in the New Florence-Seward district. Approximately 2,663 acres of this coal have been exploited by large scale mining. and the total reported production up to 1952 amounts to about 13,305,000 tons. It is estimated that approximately 8,600 acres in this district contains Lower Kittanning coal classified as measured reserves 28 inches and more thick (Plate 11). Nearly all of this coal is low-volatile bituminous rank. The Lower Kittanning lies well below the surface throughout most of the district; cropping out in the Conemaugh River east of Boltz and on the sides of Laurel Hill.

Penelec no. 5 mine. Penelec no. 5 is a slope mine located at Robindale on a branch of the Pennsylvania Railroad (Cb 6). This mine is operated

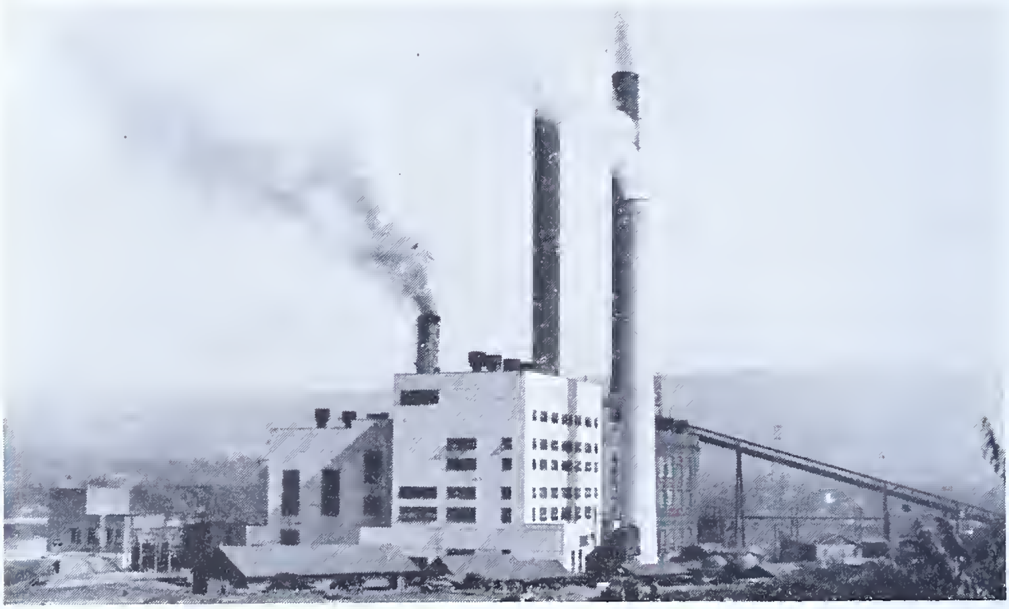


Figure 11. West Penn Power Company plant at Robindale.

by the West Penn Power Company, and the entire output of coal is used for electric power in the plant at the site of the mine. Formally known as the Robindale mine, it was opened 1914 and operated by Conemaugh Smokeless Coal Company until 1926 when it was acquired by the present operators. Reported total production from this mine up to and including 1952 is about 6,573,000 tons. An area of approximately 1,725 acres has been mined, but it is surrounded by very large reserves (Plate 11). The coal bed is from 32 to 47 inches thick and contains some impurities. The bed was measured and sampled at four points in the mine by U. S. Bureau of Mines in 1916, following are the sections: (see analyses Table 7.)

Sections of Lower Kittanning coal in Penelec No. 5 mine (Cb 6)

Sections	A		B		C		D	
Laboratory No.	25135		25136		25137		25138	
	Ft.	*In.*	*Ft.*	*In.*	*Ft.*	*In.*	*Ft.*	*In.*
Roof, coal, and bone:								
Coal	1	9		10½		5	1	3
Sulphur		¼		⅛		¼		
Coal		9		4	2	5		
Shale band				a¼				
Bony coal		⅛				½		
Bone and sulphur								a1
Coal		9	2	2	1	0	1	4
Floor, fire clay:								
Thickness of bed	3	3⅜	3	4⅞	3	10¾	2	8
Thickness of sample	3	3⅜	3	4⅝	3	10¾	2	7

---

[a] Not included in sample

Sample A was measured at face of aircourse of dip heading. Sample B was measured at face of 1 room, 1 north parallel. Sample C was measured at face of 1 left main heading. Sample D was measured 30 feet from foot of slope at face of proposed drainageway to the dip heading.

The character and thickness of the Lower Kittanning coal in and adjacent to the mined area is shown in the graphic sections of core drill holes on (Plate 3, sections 23, 26, 27, 28, 29; Plate 4, sections 7, 8, 9, 17, 18, 19, 20, 21, 22).

Diamond no. 1 and 2 mines. Diamond no. 1 mine at Boltz (Ca 80) was started in 1915 by Cramer Coal and Coke Company. It was operated sometime later by Diamond Smokeless Coal Company, and was finally taken over by Imperial Coal Company, who in 1920 opened another entry, called Diamond no. 2, a short distance beyond the east boundary of the New Florence quadrangle, wherein present operations are being pursued. About 337 acres of the worked area through Diamond no. 1 is in the New Florence quadrangle (Plate 11) and approximately 1,747,000 tons of coal have been mined out and lost. Mining was not expanded farther into this area apparently because thinner coal was encountered in advance workings. However, core drilling to the north and west of these limits has disclosed that economically minable Lower Kittanning coal underlies a very large area. (Plate 11.) The bed thickness ranges from 30 to 63 inches; thicker beds commonly contain one or two relatively thick partings or binders in the lower part. Sections of the Lower Kittanning as found in these test holes are shown graphically on (Plate 2, sections 1, 2; Plate 3, sections 17-25; Plate 4, sections 1-7, 10-16).

Sections of the Lower Kittanning north of Boltz in the Johnstown quadrangle are shown on (Plate 1, sections 21, 22, 20; Plate 2, sections 18, 19, 20, 22; Plate 3, sections 1, 2).

Analyses of coal as shipped and delivered are given on Table 8.

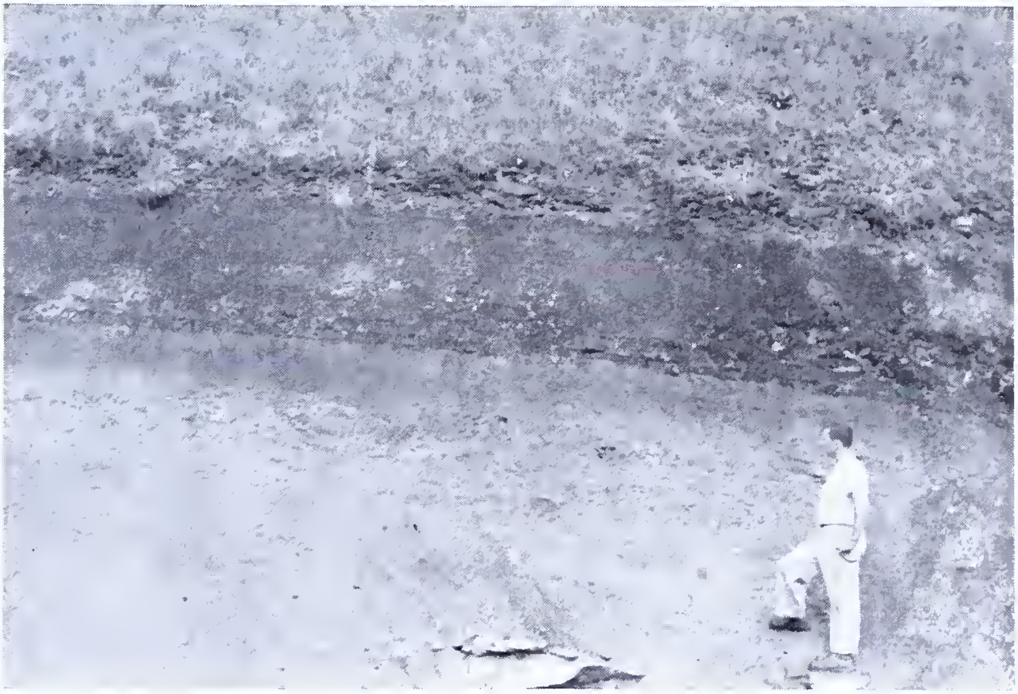


FIGURE 12. Lower Kittanning coal, clay and top of Homewood sandstone, on Pa. Route 711 east of Boltz.

Valley no. 2 mine. The Valley no. 2 is a shaft mine south of Seward (Cb 9). The history of the early development of this mine is uncertain, but apparently mining was completed in 1923 by the Irwin Gas Coal Company, who reported production of 408,000 tons of Lower Kittanning Coal. It was estimated, however, that the developed area of the mine constitutes about 537 acres, wherein approximately 2,700,000 tons of coal have been mined out and lost. An appreciable tonnage of coal was recently strip-mined in this locality. The following sections of the coal had been measured in the strip mine.

Sections of Lower Kittanning coal in strip mine (Cb 10)

	Ft.	*In.*
Roof, shale		
Bony coal	0	4
Coal with lenses of sulphur	3	2
Floor, shale		
Thickness of coal section	3	2

(Cb 11)

	Ft.	*In.*
Roof, shale		
Bony coal	0	4
Coal	1	4
Shale parting		1¼
Coal	1	2
Floor, impure clay		
Thickness of coal section	2	7½

Freedom mine. The Freedom mine is at the foot of Laurel Hill east of New Florence (Cb 16). This was a relatively small project on the Lower Kittanning coal which was begun in 1920 and abandoned in 1925, producing about 37,000 tons. The following measurement of the coal bed was obtained at the pit mouth.

Section of Lower Kittanning coal in Freedom mine (Cb 16)

	Ft.	*In.*
Roof, shale		
Bony coal	0	5
Coal, some sulphur streaks	3	0
Floor, shale		
Thickness of coal section	3	0

Werder mine. The Werder mine is on Baldwin Creek south of New Florence (Cb 19). Beginning in 1905, this mine was worked for house coal. When a lumber company laid rails along the creek in 1916, the mine was operated on a limited commercial basis by the Dickey Coal Company; the project was discontinued in 1919. A reported typical section of the coal bed is as follows:

Section of Lower Kittanning in Werder mine (Cb 19)

	Ft.	*In.*
Roof, shale or sandstone		
Coal	1	4
Shale binder	0	3
Coal	2	8
Thickness of coal section	3	3

A former foreman of the mine claims that this coal is the Middle Kittanning, but this does not fit the geologic relationship in this locality, and the bed is here considered the Lower Kittanning.

Southeast District

West side of Laurel Hill. Nothing was learned directly or indirectly concerning the Lower Kittanning coal along its outcrop from Baldwin Creek to the southern boundary of the quadrangle. But considering the persistent habit of this coal bed, it is likely that it is present in minable proportions. A coal which is considered Lower Kittanning was exposed in a trench on the south branch of Mill Creek east of Kissel Springs (Ba 31). The bed is 46 inches thick, but it contains relatively thick impurities. Following is the section:

Section of Lower Kittanning coal east of Kissel Springs (Ba 31)

	Ft.	*In.*
Roof, shale		
Coal	0	10½
Bony coal	0	3
Coal	0	9
Bony coal	0	5
Coal	1	6½
Floor, clay		
Thickness of coal section	3	10

East side of Laurel Hill. Information about the Lower Kittanning coal is meager on the east side of Laurel Hill where the coal horizon underlies an area of approximately 2,905 acres in the New Florence quadrangle. As indicated from some core drill holes in this area and immediately east in the Johnstown quadrangle, the bed appears not to have present commercial possibilities. Sections of the coal bed revealed in core drill holes are shown on (Plate 2, sections 24, 25; Plate 4, sections 26-29).

Brookville Coal

As was pointed out previously, data concerning the Brookville coal in the New Florence quadrangle are meager, but indications are that this coal bed is generally thin or missing. The Brookville coal was strip-mined for a distance of approximately 2,500 feet northeast of Josephine (Ba 3). The coal ranges from 42 to 46 inches thick; a typical bed section as follows:

Section of Brookville coal in strip mine (Ba 3)

	Ft.	*In.*
Roof, shale		
Cannel shale	0	8
Clay	0	6
Coal with lenses and streaks of sulphur	3	8
Thickness of coal section	3	8

The Brookville is erratic in habit, but from the uniformity and extent of the coal revealed in this strip mine, it probably extends a considerable distance in from the outcrop.

A country bank, now inaccessible, on the Brookville coal is west of Heshbon (Ba 19). It was reported that the coal bed is 34 inches thick.

The cut on the railroad west of Scottglen (Ca 37) revealed a section of the Brookville coal as follows:

Section of Brookville coal west of Scottglen (Ca 37)

	Ft.	*In.*
Roof, sandstone	40	0
Coal	0	7
Shale parting	0	1¾
Coal	0	7
Shale parting	0	4½
Coal	0	10
Floor, shale		
Thickness of coal section	30	¼

COAL RESERVES

Purpose of Estimate

Rapid depletion of the reserves of the fabulous Pittsburgh coal bed has created the necessity of an inventory of lesser coals suitable for making metallurgical coke, particularly the coals occurring in the Allegheny series in the bituminous fields of Pennsylvania. Reese and Sisler (1928) estimated the coal reserves in the bituminous fields of Pennsylvania, but the wide scope of the work precluded the possibility of detailed field investigation, and estimates of reserves in some areas were based on the presumed presence of a coal bed, whereas later detailed geologic mapping disclosed that certain coal beds are thin or missing in those areas. In 1943, the U. S. Bureau of Mines started a program for an investigation of known minable reserves of coal that were or could be made suitable for the manufacture of metallurgical coke (this project has recently been taken over by the U. S. Geological Survey). U. S. Bureau of Mines, Report of investigation 4757 (1950) and 4803 (1951) Estimates of Known Recoverable Reserves of Coking Coal in Indiana and Westmoreland counties respectively includes estimates of the coal reserves in the New Florence quadrangle. These estimates in the quadrangle were made without benefit of detailed geologic mapping, which is particularly essential to the identity of the coal beds from place to place. Since the geologic mapping has been completed in the New Florence quadrangle, it is in order that revised estimates of the coal reserves be made. These estimates are presented in the accompanying tables.

The survey of the New Florence quadrangle revealed that there are three known major coal beds of economic value; they are in order of importance; Lower Kittanning (B) coal, Upper Freeport (E) coal and Lower Freeport (D) coal. Minor coal beds for which estimates of reserves have also been made are the Brookville (A) coal, Upper Kittanning (C) coal, and Lower Kittanning "B" rider coal.

There are large untested areas in the quadrangle which, based on geologic probability, may contain potential coal reserves of considerable magnitude. Exploratory core drilling in these areas may therefore not only add considerably to the estimates of the known major coal reserves, but also find coals of minor importance having minable thickness and fair continuity.

The areal distribution of coal beds in the New Florence quadrangle for which reserve estimates have been computed is shown on Plates 9-12. The estimated known reserves of coal is presented in Tables 2-6.

Procedures and Definitions

An estimate of coal reserves is, to some extent, an abstract problem based on a series of assumptions in addition to the facts available from geologic observations, mining and drilling. The procedures here employed for appraisal, estimation, and reporting estimates conform generally to those agreed upon by the U. S. Bureau of Mines and the Fuel Branch of the U. S. Geological Survey, which tend toward uniformity (U. S. G. S. Circular 94, Coal Resources of the United States, 1950).

Unit Area. Reserves are reported for townships and parts of townships (including boroughs with the nearest township) within the quadrangle so that they may be combined in county, state, and national totals.

Overburden. All of the reserves in the measured and indicated classes are under less than 1,000 feet of cover, and only very small amounts of inferred reserves are under more than 1,000 feet of cover. Calculation of strip-mine reserves and the ratio of thickness and type of overburden to thickness of coal is too complicated to be attempted.

Classes of reserves. On the basis of the relative abundance of reliable data, the reserves are reported in three separate classes, known as measured, indicated, inferred.

Measured coal. Measured coal is coal for which tonnage is computed from measurements revealed in outcrops, trenches, mine workings, and drill holes. The points of observation and measurement are so closely spaced, and the thickness and extent of the coal is so well defined that the computed tonnage is judged to be accurate within 20 percent, or less, of the true tonnage. The spacing of the points of observation necessary to demonstrate continuity of a coal vary according to the habit of the coal beds. The points of observations are, in general, on the order of one-half mile apart. The outer limit of a block of measured coal, therefore, shall be on the order of one-quarter mile from the last point of positive information (i. e., roughly one-half the distance between points of observation).

Where no data are available other than measurements along the outcrop, but where the continuity of the outcrop is measured in miles and suggests the presence of coal at great distance in from the outcrop, a smooth line drawn roughly one-half mile in from the outcrop, shall be used to mark the limit under cover of a block of coal that can also be classified as measured.

Indicated coal. Indicated coal is coal for which tonnage is computed partly from projection of visible data for a reasonable distance on geologic evidence. In general, the points of observation are on the order of 1 mile apart, but may be as much as 1½ miles for beds of known geologic continuity. For example, if drilling on one-half mile centers has proved up a block of measured coal of fairly uniform thickness and extent, the area of measured coal is, according to the judgment of the estimater, larger than the actual area of drilling by as much as one-quarter mile on all sides. If from geologic evidence, the bed is believed to have greater continuity the area of measured coal is surrounded by a belt of indicated coal, which according to the judgment of the appraiser, may be as much as 1½ miles wide.

Where there are no data available other than measurements along the outcrops, but where the continuity of the outcrop is measured in miles and suggests the presence of coal at great distances in from the outcrop, two lines drawn roughly parallel to the outcrops, one-half mile from the outcrop, and one 2 miles in from the outcrop define a block of coal that may be classed as indicated.

Inferred coal. Inferred coal is coal for which quantitative estimates are based largely on broad knowledge of the geologic habit of the bed or region and for which there are few, if any, measurements. The estimates are based on the assumed continuity for which there is geologic evidence. In general, inferred coal lies more than 2 miles from the outcrop.

Thickness of beds. Coal reserves are calculated and reported by beds in categories of thickness as follows:

14 to 28 inches
28 to 42 inches
More than 42 inches

The thickness of beds used in making the reserve calculations is obtained from weighted average figures, expressed to the nearest whole inch. Partings of more than three-eighths inch thick are omitted in determining the thickness of individual beds. Top and bottom benches of coal that normally would be left in mining are also omitted.

Weight of coal. Estimated tonnage of coal in place is based on an average weight of 1,800 short tons per acre foot, or 150 per acre inch.

Percentage of recovery. The result of other estimates indicate that from the total-resource point of view, the recoverability of coal in the ground is about 50 percent. This includes coal that is legally required to be left unmined such as in barrier pillars, around oil and gas wells, under towns, roads, railroads and streams.

Recoverable reserves. The recoverable reserves are based on a minimum bed thickness of 28 inches, which is about the minimum bed thickness being mined by hand-loaded conveyors in the bituminous fields.

Mined and lost. The area within the limits of the developed area of a mine is taken as mined and lost. No attempt was made to determine the amount of coal left in stumps and pillars that possibly could be recovered in mining.

TABLE 2. ESTIMATED KNOWN RESERVES OF UPPER FREEPORT COAL, 1951

COUNTY	TOWNSHIP	AREA OF TOWNSHIP IN QUADRANGLE ACRES	AREA OF COAL LOST BY EROSION ACRES	AREA UNDERLAIN BY COAL 0" TO 14" THICK ACRES	COAL OVER 14" THICK IN PLACE BEFORE MINING ACRES	MINED OUT AND LOST ACRES	COAL OVER 14" THICK REMAINING ACRES	MEASURED INDICATED INFERRED	COAL RESERVES IN TONS OF 2,000 POUNDS						TOTAL COAL RESERVES IN TONS OF 2,000 POUNDS				RECOVERABLE RESERVES 28" AND MORE THICK 50 PERCENT RECOVERY THOUSANDS OF TONS
									14" TO 28" THICK		28" TO 42" THICK		OVER 42" THICK		14" AND MORE THICK		28" AND MORE THICK		
									ACRES	THOUSANDS OF TONS	ACRES	THOUSANDS OF TONS	ACRES	THOUSANDS OF TONS	ACRES	THOUSANDS OF TONS	ACRES	THOUSANDS OF TONS	
INDIANA	BLACKLICK	5,515.0	379.4		5,135.6	502.7	4,632.9	MEASURED			102.4	559	506.5	4,583	707.9	5,131	707.9	5,131	2,565
								INDICATED			617.9	3,232	854.4	6,207	1,472.0	9,439	1,472.0	9,439	4,719
								INFERRED			2,653.0	13,813			2,653.0	13,813	2,653.0	13,813	6,906
								TOTAL			3,373.0	17,585	1,360.9	10,790	4,632.9	28,383	4,632.9	28,383	14,190
	BURRELL	11,546.0	5,851.2		7,511.2	365.0	7,146.2	MEASURED			3,734.0	19,988	1,281.8	8,844	5,015.8	28,832	5,015.8	28,832	14,416
								INDICATED			898.0	4,858	844.4	5,060	1,540.4	8,826	1,540.4	8,826	4,615
								INFERRED			590.0	3,159			590.0	3,159	590.0	3,159	1,579
								TOTAL			5,220.0	27,985	1,826.2	13,932	7,146.2	40,817	7,146.2	40,817	20,408
	BRUSH VALLEY	6,305.0	3,371.2	1,702.4	1,231.4	18.0	1,213.4	MEASURED			241.0	1,059			241.0	1,059	241.0	1,059	529
								INDICATED			249.4	1,192			249.4	1,192	249.4	1,192	596
								INFERRED	367.6	1,102	359.4	1,477			720.0	2,579	359.4	1,477	738
								TOTAL	367.6	1,102	849.8	3,728			1,213.4	4,830	849.8	3,728	1,863
	BUFFINGTON	883.2	611.0	272.2	0.0														
	CENTER	1,465.0	1,289.0		176.0	102.4	73.6	MEASURED					73.6	662	73.6	662	73.6	662	331
	EAST WHEATFIELD	10,799.0	2,190.0	8,609.0															
	WEST WHEATFIELD	19,922.0	7,365.8	4,106.8	8,447.4	484.9	7,962.5	MEASURED			871.2	4,566	1,187.7	10,039	2,058.9	14,605	2,058.9	14,605	7,302
								INDICATED			2,032.8	10,587	908.8	5,819	2,941.6	16,403	2,941.6	16,403	8,201
								INFERRED	1,436.4	4,309	1,585.9	6,818			2,922.0	11,127	1,545.8	6,819	5,409
								TOTAL	1,436.4	4,309	4,449.9	21,971	2,096.5	15,858	7,962.5	42,135	6,546.1	37,829	18,913
WESTMORELAND	DERRY	9,454.0	6,839.6		2,614.4	2.0	2,612.4	MEASURED	80.0	240	442.8	2,384			522.8	2,624	442.8	2,384	1,192
								INDICATED	140.8	422	339.2	1,232			480.0	1,654	339.2	1,232	616
								INFERRED	649.6	1,949	960.0	4,032			1,609.6	5,981	960.0	4,032	2,016
								TOTAL	870.4	2,611	1,742.0	7,648			2,612.4	10,259	1,742.0	7,648	3,824
	FAIRFIELD	30,584.0	10,000.2		20,583.8	908.6	19,675.2	MEASURED					2,325.0	13,253	2,325.0	13,253	2,325.0	13,253	6,626
								INDICATED					2,643.2	20,987	2,643.2	20,987	2,643.2	20,987	10,493
								INFERRED			14,707.0	61,770			14,707.0	61,770	14,707.0	61,770	30,880
								TOTAL			14,707.0	61,770	4,968.2	34,240	19,675.2	96,010	19,675.2	96,010	47,999
	LIGONIER	13,295.0	975.0		12,320.0		12,320.0	INFERRED			12,320.0	51,681			12,320.0	51,685	12,320.0	51,681	25,840
	ST. CLAIR	16,975.0	10,747.8	1,657.6	4,569.6		4,569.6	MEASURED					131.2	945	131.2	945	131.2	945	472
								INDICATED					169.6	1,221	169.6	1,221	169.6	1,221	610
								INFERRED	2,816.0	8,449	1,452.8	6,102			4,268.8	14,461	1,452.8	6,102	3,051
								TOTAL	2,816.0	8,449	1,452.8	6,102	300.8	2,166	4,569.6	16,627	1,753.6	8,268	20,975
CAMBRIA	UPPER YODER	3,129.0	3,097.0	32.0	0.0														
	LOWER YODER	1,785.0	1,785.0																
SOMERSET	CONEMAUGH	4,768.0	3,402.2	303.9	1,061.9		1,061.9	INFERRED	1,061.9	3,090					1,061.9	3,090			
	JENNER	1,017.2	985.2		32.0		32.0	INFERRED	32.0	10					32.0	10			
	TOTAL	145,548.4	64,863.0	16,685.9	63,803.3	2,283.6	61,519.7												
															SUMMARY				
								MEASURED	80.0	240	5,381.4	29,535	5,604.8	38,338	11,076.2	67,111	10,999.2	66,871	33,435
								INDICATED	140.8	422	4,132.0	21,081	5,220.4	52,218	9,493.2	59,722	9,352.4	59,300	29,650
								INFERRED	6,363.5	19,305	54,586.8	148,852			40,950.3	167,765	54,586.8	144,852	74,428
								TOTAL	6,584.3	19,571	44,110.2	199,468	10,825.2	76,555	61,519.7	294,588	54,939.4	270,023	137,311

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TABLE 5. ESTIMATED KNOWN RESERVES OF LOWER FREEPORT COAL, 1951

COUNTY	TOWNSHIP	AREA OF TOWNSHIP IN QUADRANGLE	AREA EXCLUDED FROM ESTIMATE	AREA OF COAL LOST BY EROSION	AREA UNDERLAIN BY COAL 0"-14" THICK	COAL OVER 14" THICK IN PLACE BEFORE MINING	MINED OUT AND LOST	COAL OVER 14" THICK REMAINING	MEASURED INDICATED	COAL RESERVES IN TONS OF 2,000 LBS.						TOTAL COAL RESERVES IN TONS OF 2,000 LBS.				RECOVERABLE RESERVES 28" AND MORE THICK 50 PERCENT RECOVERY
										14" TO 28" THICK		28" TO 42" THICK		OVER 42" THICK		14" AND MORE THICK		28" AND MORE THICK		
		ACRES	ACRES	ACRES	ACRES	ACRES	ACRES	ACRES		ACRES	THOUSANDS OF TONS	ACRES	THOUSANDS OF TONS	ACRES	THOUSANDS OF TONS	ACRES	THOUSANDS OF TONS	ACRES	THOUSANDS OF TONS	THOUSANDS OF TONS
INDIANA	BURRELL	11,540.0	4,743.4	5,402.4	403.0	1,931.2		1,931.2	MEASURED	96.0	336					96.0	336			
									INDICATED	1,080.0	3,564	755.2	3,393			1,835.2	6,957	755.2	3,393	1,697
									TOTAL	1,176.0	3,900	755.2	3,393			1,931.2	7,292	755.2	3,393	1,697
	BRUSH VALLEY	8,305.0	1,240.8	2,945.0	1,721.6	377.6		377.6	MEASURED											
									INDICATED	377.6	928					377.2	926			
									TOTAL	377.6	928					377.2	926			
	EAST WHEATFIELD	10,799.0	5,070.8	2,382.2	2,868.0	2,678.0		2,678.0	MEASURED	153.6	345	322.8	1,896	460.8	2,972	937.2	5,213	783.6	4,868	2,434
									INDICATED	544.0	1,446	934.4	4,605	262.4	1,572	1,740.8	7,623	1,196.8	6,177	3,088
									TOTAL	697.6	1,791	1,257.2	6,501	723.2	4,544	2,678.0	12,836	1,980.4	11,045	5,522
	WEST WHEATFIELD	12,992.0	6,370.4	1,616.0		5,000.8	454.0	4,546.8	MEASURED	160.0	448	1,014.8	8,011	448.0	2,357	1,622.8	10,816	1,462.8	10,368	5,184
									INDICATED	722.2	2,372	1,708.8	8,412	492.8	2,656	2,923.8	13,440	2,201.6	11,068	5,534
									TOTAL	882.2	2,820	2,723.6	16,423	940.8	5,013	4,546.6	24,256	3,664.4	21,436	10,718
													SUMMARY							
									MEASURED	409.6	1,129	1,337.6	9,907	908.8	5,329	2,656.0	16,364	2,246.4	15,236	7,618
									INDICATED	2,723.8	8,310	3,398.4	16,410	755.2	4,228	6,877.0	28,946	4,153.6	20,638	10,319
									TOTAL	3,133.4	9,439	4,736.0	26,317	1,664.0	9,557	9,533.0	45,310	6,400.0	35,874	17,937

TABLE 4 ESTIMATED KNOWN RESERVES OF LOWER KITTANNING COAL

COUNTY	TOWNSHIP	AREA OF TOWNSHIP IN QUADRANGLE	AREA OF COAL LOST BY EROSION	COAL OVER 14" THICK BEFORE MINING	MINED OUT AND LOST	COAL OVER 14" THICK REMAINING	MEASURED INDICATED INFERRED	COAL RESERVES IN TONS OF 2,000 POUNDS: 14" TO 28" THICK		28" TO 42" THICK		OVER 42" THICK		TOTAL COAL RESERVES IN TONS OF 2,000 POUNDS: 14" AND MORE THICK		28" AND MORE THICK		RECOVERABLE RESERVES 28" AND MORE THICK 50 PERCENT RECOVERY THOUSANDS OF TONS
		ACRES	ACRES	ACRES	ACRES	ACRES		ACRES	THOUSANDS OF TONS	ACRES	THOUSANDS OF TONS	ACRES	THOUSANDS OF TONS	ACRES	THOUSANDS OF TONS	ACRES	THOUSANDS OF TONS	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	MEASURED			[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
							INDICATED			[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
							INFERRED			[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
							TOTAL			[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	MEASURED			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
							INDICATED			[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
							INFERRED			[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
							TOTAL			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	MEASURED			[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
							INDICATED			[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
							TOTAL			[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	MEASURED			[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
							INDICATED			[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
							TOTAL			[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	MEASURED			[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	MEASURED			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
							INDICATED					[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
							TOTAL			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	MEASURED			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
							INDICATED			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
							INFERRED			[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
							TOTAL			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	INFERRED			[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	MEASURED			[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
							INDICATED			[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
							INFERRED			[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
							TOTAL			[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	INFERRED			[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	MEASURED			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
							INDICATED			[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
							INFERRED			[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
							TOTAL			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	MEASURED	[illegible]	[illegible]					[illegible]	[illegible]			
	[illegible]	[illegible]	[illegible]															
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	MEASURED	[illegible]	[illegible]					[illegible]	[illegible]			
							INDICATED	[illegible]	[illegible]					[illegible]	[illegible]			
							INFERRED	[illegible]	[illegible]					[illegible]	[illegible]			
							TOTAL	[illegible]	[illegible]					[illegible]	[illegible]			
	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	MEASURED	[illegible]	[illegible]					[illegible]	[illegible]			
	TOTAL	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]												
							MEASURED	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
							INDICATED	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
							INFERRED	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
							TOTAL	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

TABLE 5. ESTIMATED KNOWN RESERVES OF UPPER KITTANNING, LOWER KITTANNING ("B") RIDER AND BROOKVILLE COALS. 1951

UPPER KITTANNING COAL

COUNTY	TOWNSHIP		COAL 28" TO 42" THICK ACRES	THOUSANDS OF TONS
CAMBRIA	UPPER YODER	MEASURED	101.5	536
		INDICATED	32.0	168
		TOTAL	133.5	704
SOMERSET	CONEMAUGH	MEASURED	352.0	1,848
		INDICATED	1,259.8	6,298
		TOTAL	1,611.8	8,146
	JENNER	MEASURED	115.2	604
		INDICATED		
		TOTAL	115.2	604
			SUMMARY	
		MEASURED	568.7	2,988
		INDICATED	1,291.8	6,466
		TOTAL	1,860.5	9,454

LOWER KITTANNING ("B") RIDER COAL

COUNTY	TOWNSHIP		COAL 14" TO 28" THICK ACRES	THOUSANDS OF TONS
INDIANA	BRUSH VALLEY	MEASURED		
		INDICATED	428.8	1,220
		TOTAL	428.8	1,220
	EAST WHEATFIELD	MEASURED	4,102.4	13,487
		INDICATED	1,792.0	5,376
		TOTAL	5,894.4	18,863
	WEST WHEATFIELD	MEASURED	313.6	940
		INDICATED	668.8	2,006
		TOTAL	982.4	2,946
WESTMORELAND	ST CLAIR	MEASURED	2,066.0	6,969
		INDICATED	969.2	3,489
		TOTAL	3,035.2	10,458
			SUMMARY	
		MEASURED	6,482.0	21,396
		INDICATED	3,858.8	12,091
		TOTAL	10,340.8	33,487

BROOKVILLE COAL

COUNTY	TOWNSHIP		COAL OVER 42" THICK ACRES	THOUSANDS OF TONS
INDIANA	CENTER	MEASURED	198.0	1,250
		INDICATED	371.2	2,450
		TOTAL	569.2	3,700

TABLE 6. SUMMARY OF ESTIMATED KOWN RESERVES OF COAL IN NEW FLORENCE QUADRANGLE. 1951

	TOTAL COAL RESERVES IN TONS OF 2,000 LBS.										RECOVEABLE RESERVES
	14" TO 28" THICK		28" TO 42" THICK		OVER 42" THICK		14" AND MORE THICK		28" AND MORE THICK		28" AND MORE THICK 50 PERCENT RECOVERY
	ACRES	THOUSANDS OF TONS	ACRES	THOUSANDS OF TONS	ACRES	THOUSANDS OF TONS	ACRES	THOUSANDS OF TONS	ACRES	THOUSANDS OF TONS	THOUSANDS OF TONS
MEASURED	8,280.8	26,690	22,441.7	112,257	12,817.3	85,199	43,539.8	224,065	35,259.0	197,456	98,728
INDICATED	7,126.6	22,030	16,107.8	89,433	8,254.2	57,463	33,488.6	168,926	26,362.0	146,896	73,448
INFERRED	7,707.5	22,941	94,579.5	414,639			102,287.0	437,580	94,579.5	414,639	207,319
TOTAL	23,114.9	71,661	135,129.0	616,329	21,071.5	142,662	179,315.4	830,571	156,200.5	758,991	379,495

TABLE 7. PROXIMATE AND ULTIMATE ANALYSES OF COAL MINE SAMPLES

NAME AND LOCATION OF MINE	COAL BED	THICKNESS OF BED FT IN	THICKNESS OF SAMPLE FT. IN	LABORATORY NO.	LOCATION IN MINE	SAMPLE CONDITION	PROXIMATE, PERCENT				ULTIMATE, PERCENT					AIR-DRY LOSS, PERCENT	B.T.U.	ASH-SOFTENING TEMPERATURE °F
							MOISTURE	VOLATILE MATTER	FIXED CARBON	ASH	SULFUR	HYDROGEN	CARBON	NITROGEN	OXYGEN			
CORAL (POTTER) Aa45	UPPER FREEPORT	6-1	4-10	85506	8 ROOM, 4 FLAT SECTION	1	1.6	24.1	67.6	6.7	0.7					1.4	14,200	2,800
DO	DO	5-11	4-8	85507	19 ROOM, 2 SLOPE 3 1/2 FLAT SECTION	1	1.8	24.7	65.5	7.0	.9					1.3	14,140	2,200
DO	DO	6-11/2	4-10	85508	7 ROOM, 4 BUTT, 2 SLOPE, 3 FLAT SECTION	1	2.2	24.5	65.9	7.4	1.3					1.7	13,990	2,150
DO	DO	6-11/2	5-0	85509	1 ROOM, 2 SLOPE, 2 1/2 FLAT SECTION	1	2.0	24.3	65.7	8.0	1.1					1.6	13,980	2,200
DO	DO			85510	COMPOSITE OF 85506 TO 85509	1	1.9	24.0	65.9	7.4	1.0	4.9	80.1	1.7	4.9	1.5	14,090	
						2		25.3	67.2	7.5	1.0	4.8	81.7	1.8	3.2		14,370	
						3		27.4	72.6		1.1	5.2	88.3	1.9	3.5		15,530	
McFEELY BRICK "E" Bb13	DO	6-4 1/2	5-5 1/2	85579	FACE OF 2 ROOM, 2 RIGHT HEADING	1	2.2	25.9	63.0	8.9	3.4					1.7	13,790	2,240
	DO	6-8	5-2	85580	FACE OF 6 ROOM, 2 RIGHT HEADING	1	2.5	27.2	63.0	7.5	3.1					1.6	13,910	2,220
				85581	COMPOSITE OF 85579 AND 85580	1	2.3	26.2	63.4	8.1	3.2	4.9	77.4	1.5	4.9	1.7	13,850	
						2		26.8	64.9	8.3	3.3	4.7	79.2	1.6	2.9		14,170	
						3		29.3	70.1		3.6	5.1	86.4	1.7	3.2		15,450	
PACKSADDLE Aa54	DO	3-4 1/2	3-1	85403	FACE OF DIP AIRCOURSE	1	3.1	26.8	62.5	7.6	1.2					2.0	13,790	2,570
DO	DO	3-4 1/2	5-1/2	85404	FACE OF MAIN ENTRY	1	2.2	27.4	62.4	7.0	1.4					2.0	13,850	2,390
				85405	COMPOSITE OF 85403 AND 85404	1	2.7	26.9	62.7	7.7	1.2	4.9	77.9	1.3	7.0	2.3	13,850	
						2		27.6	64.5	7.9	1.3	4.7	80.1	1.3	4.7		14,230	
						3		25.0	70.0		1.4	5.1	87.0	1.4	5.1		15,460	
STRANGFORD Aa50	DO	3-8	3-7	85657	23 BUTT, DIP FLAT HEADING	1	2.6	27.0	62.3	8.1	.9					1.9	13,840	2,740
DO	DO	3-7	3-6	85658	1 ROOM, 28 RIGHT MAIN FLAT HEADING	1	2.2	27.5	58.3	11.4	3.2					1.6	13,290	2,140
DO	DO	3-7	3-6	85659	1 ROOM, 29 RIGHT MAIN FLAT HEADING	1	2.4	28.5	57.8	11.3	2.6					1.8	13,300	2,240
				85660	COMPOSITE OF 85657 TO 85659	1	2.3	27.6	59.9	10.2	2.3	4.9	75.6	1.3	5.7	1.8	13,480	2,240
						2		28.2	61.4	10.4	2.3	4.7	77.4	1.4	3.8		13,790	
						3		31.5	68.5		2.6	5.3	86.6	1.5	4.2		15,400	
BELLS MILL Ad9	LOWER KITTANNING	3-8	3-6	85502	FACE OF MAIN FLAT ENTRY	1	2.2	24.6	64.5	8.7	3.0					1.9	13,800	2,060
DO	DO	3-7 1/2	3-2	85503	10 RIGHT BUTT, MAIN DIP HEADING	1	2.2	24.5	66.0	7.4	2.0					1.9	14,130	2,180
DO	DO	3-3 1/2	3-3 1/2	85504	FACE OF MAIN DIP HEADING	1	2.7	23.4	64.8	9.1	3.4					2.5	13,710	2,200
				85505	COMPOSITE OF 85502 TO 85504	1	2.3	24.8	64.5	8.4	2.8	4.9	77.9	1.3	4.7	2.1	13,860	
						2		25.4	66.0	8.6	2.9	4.7	79.7	1.4	2.7		14,180	
						3		27.7	72.3		3.2	5.2	87.3	1.5	2.8		15,520	
BRUSH VALLEY Ca50	DO	3-9 3/8	3-8 1/8	22501	FACE OF 6 RIGHT ENTRY	1	5.2	20.6	66.4	7.8	3.1					4.7	13,710	2,200
DO	DO	3-10 1/16	3-10 1/16	22502	PILLAR, 36 ROOM, 7 RIGHT HEADING	1	2.2	22.7	67.5	7.6	2.8					1.6	14,230	2,300
DO	DO	4-1 1/4	3-11 3/8	22503	FACE OF 8 RIGHT BACK ENTRY	1	4.2	20.6	67.3	7.9	2.6					3.6	13,870	2,240
DO	DO	3-6 1/2	3-8 1/2	22504	FACE OF 11 RIGHT BACK ENTRY	1	3.0	20.8	64.8	7.8	2.8					2.4	14,040	2,200
DO	DO	4-2 1/8	3-7	22505	1 BUTT BACK ENTRY, 5 LEFT ENTRY	1	3.2	20.5	68.4	7.9	3.2					2.7	14,030	2,280
				22506	COMPOSITE OF 22501 TO 22505	1	3.6	20.9	67.6	7.9	2.9	5.0	76.2	1.3	4.7	3.0	13,540	
						2		21.7	70.1	8.2	3.0	4.8	81.0	1.3	1.7		14,450	
						3		23.7	76.6		3.3	5.2	88.3	1.4	1.8		15,740	
ROBINDALE (PENELEC) Cd6	DO	3-3 3/8	3-3/8	25135	FACE OF AIRCOURSE, DIP HEADING	1	1.4	18.9	70.5	9.2	2.4					.8	13,930	2,480
DO	DO	3-4 7/8	3-4 5/8	25136	1 ROOM, 1 NORTH PARALLEL	1	2.5	18.2	71.7	7.6	2.1					2.0	14,260	2,470
DO	DO	3-10 3/4	3-10 3/4	25137	FACE OF 1 LEFT, MAIN HEADING	1	2.4	20.1	70.9	6.6	2.0					2.0	14,280	2,440
DO	DO	2-8	2-7	25138	NEAR FOOT OF DRAINAGEWAY	1	2.6	19.1	70.3	6.4	2.2					2.1	14,120	2,460
				25139	COMPOSITE OF 25135 TO 25138	1	2.2	19.2	70.9	7.7	2.2	4.8	80.6	1.3	3.4	1.7	14,090	
						2		19.7	72.4	7.9	2.3	4.7	82.4	1.3	1.4		14,410	
						3		21.4	78.6		2.4	5.1	89.5	1.4	1.5		15,650	

TABLE 8 PROXIMATE ANALYSES OF COAL AS SHIPPED AND DELIVERED

NAME AND LOCATION OF MINE	COAL BED	SIZE OF COAL	PROXIMATE ANALYSES PERCENT: MOISTURE AS RECEIVED	PROXIMATE ANALYSES PERCENT, DRY COAL: VOLATILE MATTER	DRY COAL: FIXED CARBON	DRY COAL: ASH	DRY COAL: SULFUR	B.T.U. PER POUND: AS RECEIVED	B.T.U. PER POUND: DRY COAL	B.T.U. PER POUND: MOISTURE-FREE AND ASH-FREE	NUMBER OF ANALYSES AVERAGED	SOFTENING TEMPERATURE DEGREES F	NUMBER OF SOFTENING TEMPERATURES AVERAGED
1	2	3	4	5	6	7	8	9	10	11	12	13	14
BOLIVAR NO.1 Bb15	UPPER FREEPORT	RUN OF MINE	2.3	25.9	60.4	13.7	4.0	13,100	13,410	15,540	1	2,260	1
LACOLLE (MONARCH NO.1) Bb20	DO	DO	2.8	24.3	58.7	17.0	2.6	12,500	12,810	15,440	1	2,610	1
DO	DO	DO	3.0	24.3	63.0	12.0	1.8	13,070	13,470	15,460	54	2,540	1
DO	DO	LUMP	1.7	24.1	61.4	14.5	3.0	12,950	13,170	15,400	7		
DO	DO	3" NUT & SLACK	1.7	23.8	65.5	10.7	1.9	13,690	13,920	15,580	1	2,410	
DO	DO	2 3/4" NUT & SLACK	2.9	24.0	63.9	12.1	1.6	13,230	13,630	15,500	1	2,550	1
LACOLLE (MONARCH NO.) Bb20	DO	RUN OF MINE	2.4	24.3	63.2	12.5	2.6	13,290	13,610	15,550	1	2,350	1
COAAL (POTTER) A83	DO	DO	2.0	24.2	66.0	9.8	1.7	13,740	14,020	15,540	2		
DO	DO	DO	1.5	23.6	66.5	9.9	1.5	13,760	13,990	15,530	3		
DO	DO	1 1/4" LUMP	1.6	23.8	66.2	10.0	1.3	13,810	14,040	15,580	1	2,510	1
DO	DO	EGG	2.8	23.2	67.4	9.4	.7	13,690	14,080	15,540	1		
DO	DO	1" X 6" EGG	1.3	23.5	66.8	9.7	1.6	13,890	14,070	15,580	10		
DO	DO	5/8" X 1 1/4" NUT (WASHED)	2.2	23.9	65.8	10.3	.7	13,650	13,970	15,570	1	2,810	1
DO	DO	1/2" SLACK	3.5	24.3	67.6	8.1	1.1	13,830	14,330	15,610	7	2,540	7
BOLIVAR NO.11 (PROGRESS) Bb15	DO	RUN OF MINE	1.7	26.1	61.0	12.9	4.2	13,260	13,490	15,450	4		
DO	DO	DO	1.5	26.4	61.7	11.9	3.4	13,440	13,650	15,500	1		
RIDGEVIEW Bb 17,16,16	DO	DO	1.7	24.3	57.0	18.7	3.4	12,260	12,470	15,350	1	2,370	1
DO	DO	DO	4.5	23.7	61.0	15.3	2.8	12,450	13,040	15,400	1		
DO	DO	DO	2.4	24.6	61.9	13.5	2.4	13,040	13,360	15,450	2		
HESHBON NO.2 Bb25	LOWER FREEPORT	DO	4.1	24.0	66.2	9.8	1.0	13,370	13,940	15,450	1	2,720	1
DO	DO	2" LUMP	2.5	23.8	67.2	9.0	1.0	13,800	14,140	15,540	1	2,730	1
DO	DO	0 X 2"	4.8	23.9	66.8	9.3	1.0	13,350	14,030	15,470	1	2,750	1
DO	DO	DO	1.7	23.8	67.5	8.7	1.2	13,940	14,180	15,530	6	2,720	6
BELLS MILL A39	LOWER KITTANNING	RUN OF MINE	2.1	23.4	66.5	10.1	2.9	13,730	14,010	15,590	1	2,230	
DO	DO	2" LUMP	1.6	24.7	63.9	11.4	3.7	13,620	13,840	15,620	2		
DO	DO	DO	2.0	24.2	64.7	11.1	4.0	13,550	13,830	15,360	20		
BUENA VISTA NO.1 (VIRGINIAN NO.13) C212	DO	RUN OF MINE	1.7	23.2	68.1	8.7	3.5	14,030	14,270	15,630	1	2,210	1
DIAMOND SMOKELESS C380	DO	DO	1.5	19.7	70.2	10.1	2.7	13,810	14,020	15,590	1	2,340	1
DO	DO	DO	3.1	19.5	70.7	9.8	2.7	13,610	14,050	15,550	5		
DO	DO	DO	2.5	19.6	71.2	9.2	2.2	13,660	14,030	15,450	2		
DO	DO	DO	2.7	19.7	71.8	8.5	2.6	13,990	14,370	15,700	1	2,420	1
DO	DO	DO	2.3	19.4	72.8	7.8	2.4	14,130	14,460	15,690	2		
DO	DO	DO	3.2	20.3	72.1	7.6	2.4	14,040	14,500	15,660	5	2,400	3
DO	DO	EGG	2.7	20.4	71.3	8.3	2.4	13,820	14,200	15,490	2		
DO	DO	2" NUT & SLACK	1.0	19.6	72.2	8.2	2.3	14,220	14,360	15,640	4	2,350	4
DO	DO	RUN OF MINE	2.3	19.1	71.0	9.9	3.2	13,740	14,060	15,600	7		
DO	DO	3/4" X 2"	1.4	19.2	72.3	8.5	2.1	14,090	14,280	15,620	1	2,230	1
FREEDOM NO.1 Cb16	DO	RUN OF MINE	2.6	19.5	69.8	10.7	2.4	13,610	13,970	15,640	1	2,480	1
DO	DO	DO	2.4	18.0	70.9	11.1	2.9	13,450	13,760	15,500	4		
DO	DO	DO	1.9	19.1	68.6	12.3	2.8	13,350	13,610	15,520	4		
GARFIELD NO.2 B52	DO	RUN OF MINE	1.0	22.8	69.8	7.4	2.3	14,370	14,520	15,690	5	2,360	3
DO	DO	DO	1.8	22.8	69.4	7.8	2.3	14,160	14,420	15,640	6		
DO	DO	DO	1.9	23.6	67.8	8.6	2.5	14,010	14,280	15,920	3	2,450	3
DO	DO	2" LUMP	.9	23.1	69.2	7.7	2.5	14,290	14,420	15,620	1	2,340	1
DO	DO	DO	1.4	25.0	67.2	7.8	3.3	14,160	14,360	15,360	1		
DO	DO	3/4" LUMP	1.5	22.3	66.9	10.8	4.0	13,730	13,940	15,590	1	2,300	1
DO	DO	1 1/4" X 4" EGG	1.4	22.1	67.9	10.0	3.5	13,760	13,990	15,530	3		
DO	DO	DO	2.5	21.9	66.6	11.5	4.0	13,400	13,740	15,550	3		
DO	DO	3/4" SLACK	1.7	23.4	68.3	8.3	2.7	14,120	14,360	15,660	1	2,390	1
DO	DO	RUN OF MINE	2.1	22.6	68.8	8.6	2.7	13,930	14,250	15,590	11	2,360	7
DO	DO	DO	2.4	22.0	69.5	8.5	2.4	13,920	14,260	15,590	15		
DO	DO	1-1/8" LUMP	1.7	21.4	67.3	11.3	3.7	13,600	13,940	15,600	2	2,400	1
DO	DO	1" X 6"	2.8	21.5	68.7	9.8	2.7	13,640	14,030	15,550	1		
DO	DO	0-2"	2.6	22.8	69.7	7.5	2.1	14,070	14,450	15,620	27	2,440	11
DO	DO	DO	2.1	22.1	70.1	7.8	2.2	14,090	14,380	15,610	7	2,320	5
DO	DO	0-1/4"	1.3	22.6	68.4	9.0	2.9	14,000	14,180	15,580	3		
DO	DO	DO	1.8	22.1	68.4	9.5	2.2	13,760	14,040	15,310	1		
DO	DO	0-3/4"	1.9	22.1	68.9	9.0	2.8	13,930	14,190	15,590	3	2,380	5
DO	DO	DO	2.5	21.4	68.8	9.8	2.7	13,710	14,060	15,590	1	2,370	1
SUPERIOR NO.1 Bb13	DO	2" LUMP	4.8	21.4	69.5	9.1	3.4	13,500	14,160	15,600	2		
DO	DO	1" X 5"	.9	23.5	64.1	12.4	4.5	13,470	13,590	15,510	6		
THERMAL NO.13 Ca34	DO	RUN OF MINE	2.0	23.9	66.8	9.3	3.5	13,760	14,170	15,620	2		
DO	DO	DO	2.0	22.9	65.9	11.2	3.9	13,600	13,660	15,630	1	2,280	1
DO	DO	DO	1.1	22.6	68.0	9.4	3.9	14,010	14,180	15,650	1	2,160	1
DO	DO	DO	1.8	23.5	66.1	10.4	4.4	13,660	13,930	15,550	3		
DO	DO	2" LUMP	1.8	22.9	66.8	10.3	4.2	13,680	13,930	15,530	57		
DO	DO	DO	1.8	22.7	67.9	9.4	4.7	13,900	14,150	15,900	1	2,150	1
DO	DO	1 1/8" LUMP + 10% SLACK	1.9	23.0	66	10.9	4.6	13,560	13,820	15,520	1	2,060	1
DO	DO	1 1/4" X 5" EGG	1.8	22.5	67.4	10.1	4.4	13,720	13,970	15,540	1	2,120	1
DO	DO	2" X 4" EGG	1.0	22.7	66.9	10.4	4.2	13,610	13,930	15,370	1		
DO	DO	1 1/4" X 4" EGG	2.2	22.6	66.6	10.8	4.3	13,530	13,830	15,500	47		
DO	DO	2" NUT & SLACK	1.8	23.5	66.2	10.3	3.3	13,650	14,050	15,670	1	2,330	1
DO	DO	DO	1.8	23.2	66.8	10.0	3.6	13,630	14,090	15,640	26		
DO	DO	1 1/4" NUT & SLACK	2.0	23.5	66.8	9.7	3.3	13,830	14,110	15,630	1	2,310	1
DO	DO	1 1/8" NUT & SLACK	1.0	23.2	65.9	10.9	3.8	13,590	13,840	15,340	1	2,200	1
DO	DO	RUN OF MINE	1.5	23.2	65.8	11.0	4.2	13,630	13,840	15,550	3	2,090	2
DO	DO	LUMP	1.6	23.4	66.1	10.5	4.0	13,640	13,870	15,490	1		
VALLEY SMOKELESS NO.2 Cb8	DO	RUN OF MINE	1.6	18.8	71.4	9.8	3.3	13,860	14,090	15,630	1	2,380	1
DO	DO	DO	2.3	19.0	71.6	9.4	2.7	13,610	14,130	15,800	8		
VIRGINIAN NO.14 Bb16	DO	RUN OF MINE	1.9	24.9	66.6	8.5	2.7	14,030	14,320	15,650	1	2,350	1
DO	DO	DO	2.0	24.8	65.7	9.5	3.1	13,850	14,130	15,610	8		
DO	DO	DO	2.0	25.1	66.4	8.5	3.0	14,010	14,300	15,650	12		
DO	DO	DO	1.3	24.8	67.3	7.9	2.8	14,250	14,440	15,660	3		
DO	DO	2" LUMP	2.1	24.4	66.5	9.1	3.2	13,810	14,210	15,630	3		
DO	DO	DO	1.6	24.4	66.7	8.9	3.4	14,050	14,270	15,670	1		
DO	DO	DO	1.7	25.4	65.2	9.4	2.3	13,690	14,080	15,330	2		
DO	DO	1 1/8" LUMP	1.6	24.0	65.4	10.6	3.7	13,710	13,930	15,560	4		
DO	DO	1" X 6 EGG	3.1	24.0	65.9	9.6	3.3	13,760	14,210	15,720	1		
DO	DO	2" X 5" EGG	1.2	24.6	66.0	9.4	3.4	13,940	14,110	15,570	4		
DO	DO	1 1/2" X 4" EGG	1.6	23.6	68.0	8.4	2.4	14,110	14,340	15,660	1	2,250	1
DO	DO	DO	2.1	24.9	67.5	7.6	2.0	14,170	14,470	15,660	10		
DO	DO	1 1/4" X 4" EGG	1.4	24.1	66.3	9.6	3.5	13,980	14,060	15,890	11		
DO	DO	1 1/4" NUT & SLACK	2.4	25.1	66.0	8.9	2.5	13,990	14,300	15,690	1	2,390	1
DO	DO	1" SLACK	3.1	24.9	67.1	8.0	2.6	13,980	14,430	15,880	27		
DO	DO	3/4" SLACK	3.2	25.8	65.2	9.0	2.7	13,970	14,320	15,740	1	2,380	1
DO	DO	RUN OF MINE	1.9	23.5	66.8	9.7	4.1	13,770	14,040	15,880	10		
VIRGINIAN NO.13 C412 (BUENA VISTA)	DO	DO	3.1	23.3	66.8	9.9	3.5	13,620	14,060	15,800	17		
DO	DO	DO	2.2	22.8	66.6	10.6	4.3	13,580	13,810	15,340	13		
DO	DO	LUMP	2.5	23.9	66.8	9.3	3.6	13,620	14,170	15,620	2		
DO	DO	2" LUMP	2.1	22.6	67.8	9.6	4.1	13,750	14,030	15,540	6		
DO	DO	1 1/4" X 4" EGG	1.2	23.1	67.7	9.4	3.7	13,580	14,150	15,920	4		
DO	DO	RUN OF MINE	1.7	22.6	67.4	10.0	3.5	13,600	14,040	15,600	2		
DO	DO	1/2" LUMP	2.3	22.1	66.7	11.2	4.8	13,570	13,650	15,630	1	2,200	1
DO	DO	2" X 6"	1.0	22.8	66.6	10.6	4.2	13,630	13,880	15,530	6		
DO	DO	2" X 5"	3.1	22.5	67.9	9.6	3.0	13,710	14,150	15,630	1		
DO	DO	DO	1.7	21.3	67.1	11.6	4.4	13,480	13,710	15,510	5		
DO	DO	0 X 1/2"	2.5	22.4	67.9	9.7	3.3	13,760	14,120	15,640	1	2,360	1

Areas excluded from estimate. Where it is demonstrated by abundant data that a coal bed has a general erratic habit, although it is locally thick, it is considered impractical to infer reserves in any thickness class, therefore such areas are excluded from the estimate.

Natural Gas

The New Florence quadrangle has been explored for natural gas at various places, but only relatively minor commercial production has been found in the so-called "shallow sands." Four deep wells have been drilled to explore the Oriskany "sand." All were unsuccessful.

Shallow Sands

Commercial quantities of natural gas are produced only from a few wells in the northeast and northwest parts of the quadrangle. (Plate 1.) Wells drilled elsewhere in the quadrangle were dry or encountered "gas shows." The unproductive shallow wells are scattered and relatively few in number, hence it would be unwise to condemn the remaining large unexplored potential gas-producing areas as unfavorable for exploration, although the prospects are not encouraging.

The shallow "sands" occur in the lower part of the Mississippian and the upper part of the Devonian. They are lenticular, overlapping bodies of sandstone enclosed by impervious material. Gas, if present, occurs in what is called a stratigraphic trap type of accumulation, which may or may not be related to anticlinal structures. Certain physical characteristics are essential to constitute a body of sandstone as a host rock to gas, such as porosity and permeability. Rarely is gas present throughout the entire thickness of a "sand," but rather in certain porous and permeable parts, called "pay streaks."

Skeleton logs of the shallow sand wells are presented graphically on Plate 13. The driller's logs show sand names, but are omitted because they are applied at random and are inconsistent; physical characteristics are not recorded. However, correlation of sands is impractical without sample studies made by a geologist. A sample study log of the Peoples Natural Gas Company, Camilla Griffen no. 3 well shown in tabular form on page 58, gives a description of most of the sands and intervening rocks. For convenience of comparison, sand names are shown at the left on Plate 13. They are compiled from the positions where they were more frequently applied by the drillers, and correspond approximately to the positions, and sequence of the sands in the regions where the names were originally applied. Nomenclature here may apply to a single sand unit or to multiple thinner sand units.

Drillers logs of a few wells were unobtainable. Available information concerning some of these wells is as follows: West Penn Coal Company no. 1 well southwest of Clyde (Ba 40) is a dry hole. Tub Mills Colleries Company well south of Bolivar (Bb 21) was drilled to a depth of 600 feet and is a dry hole. J. Kirshner no. 1 well southwest of New Florence (Bb 38) was drilled to a depth of 2984 feet and encountered a gas show and salt water at a depth of 1080 feet. J. and R. Mellon no. 1 well northwest of Mellons (Bc 17) was drilled to a depth of 297 feet and produced a large quantity of water.

Gas Production

A group of seven wells located in the northwestern part of the quadrangle (Ca 5, 8, 10, 31, 32) are producing gas from what apparently is the Hundred Foot sand in the Lower Mississippian series (Plate 13, sections 15-21). The "pays" were found in the Hundred Foot sand from 1,040 to 1,100 feet below the Lower Kittanning coal or at depths ranging from 1,040 to 1,260 feet below the surface. The indicated yields are from 160,000 to 225,000 cu. ft. per day; rock pressures are not given. This production is confined to the Nolo anticline; the adjacent wells are unproductive. It seems, therefore, that this anticlinal structure was an influential factor in the migration of gas into the small pool.

A well north of Armagh (Ca 38) is producing gas from the Balltown sand at a depth of 3,048 feet or 2,808 feet below the Lower Kittanning coal (Plate 13, section 29). A gas "pay" was found in the Hundred Foot sand in a well northwest of Armagh (Ca 48) at a depth of 1,250 feet or 1,040 feet below the Lower Kittanning coal (Plate 13, section 25). Gas is being produced from a well north of Clyde (Ca 46) where the "pay" is in the Balltown sand at a depth of 3,166 feet or 2,666 feet below the Lower Kittanning coal (Plate 13, section 10).

Two productive wells were drilled southwest of Blacklick. An unknown quantity of gas comes from the Balltown sand in one well (Aa 34) at a depth of 3,351 feet or 2,651 feet below the Lower Kittanning coal (Plate 13, section 2). The well located one-half mile northeast from the above well (Aa 32) is reported to have had an initial production of 800,000 cu. ft. per day, also in the Balltown sand. The exact depth to the "pay" is not logged.

Deep Well Exploration

Four deep test wells have been drilled in the quadrangle to explore the Oriskany "sand" in the lower part of the Devonian system. These test wells were logically located on elongated domes along the axes of Laurel Hill and Chestnut Ridge anticlines; all were unsuccessful. The Oriskany sandstone about 65 feet thick, is known to be present in these areas, and some minor quantity of gas was encountered in the Onondaga limestone.

Laurel Hill Anticline

The Kern-Dodge well is located on the summit of Laurel Hill on the south side of Pa. Route 271 (Cc 10) and about 1,500 feet west of the axis of the anticline which here forms an elongated dome with closure of more than 50 feet. Starting in the Pocono sandstone (Big Injun sand), the well was drilled by the Altmont Gas Development Company to a depth of 6,770 feet, bottoming in the Tully limestone. The well was drilled deeper under the name of Indiana Savings Bank by the New Penn Development Corporation (Poter Development Corporation) and completed 6 feet in the top of the Oriskany at a depth of 7,725 feet on January 21, 1924. The Tully limestone, 149 feet thick, was found at a depth of 5,960 feet. Cherty Onondaga limestone, 431 feet thick, was topped at 7,588 feet, and a flow of 750,000 cu. ft. of gas per day was encountered in the Onondaga at 7,671 feet. The top of the Oriskany is at 7,719 feet and a large flow of salt water came in at 7222.5 feet. A sample study log of the Kern-Dodge well, made by Fred Whiteside of unknown affiliation is presented in the section under subsurface rocks on page 67.

A similar elongated dome, untested, lies along the axis of the Laurel Hill anticline to the northeast. The subsurface structure in this area was explored by seismograph; the results of this exploration were not obtained.

Chestnut Ridge Anticline

The Peoples Natural Gas Company has drilled three deep test wells on and near the southwestern plunging nose of an elongated dome of the Chestnut Ridge anticline in the southwestern part of the quadrangle and one well down on the west limb of the anticline in the Latrobe quadrangle; all are dry holes.

As indicated in two of these wells, the subsurface structure is complicated by an overturned anticline which is faulted. The Camilla Griffen no. 2 well (Ab 19) did not reach the Tully limestone. In the Camilla Griffen no. 1 well (Ab 18) the Tully limestone was drilled through at a depth of 7,235 feet and again at a depth of 7,990 feet. The Camilla Griffen no. 4 well (Ab 17), after reaching the Onondaga limestone, passed through an overturned anticline and the Oriskany sandstone was encountered three times in the interval between 7,392 feet and 9,200 feet. This strong folding and probable faulting at depth is not reflected at the surface in the vicinity of the wells. Surficial structure mapping of the plateau region of western Pennsylvania shows that deep seated strong folding and faulting is rarely reflected at the surface.

Drillers Log of Camilla F. Griffen well No. 1 (Ab 22)

Formation	*Top*		*Bottom*	*Formation*	*Top*		*Bottom*
Top Soil	0	—	8	Gray Slate and Shells	555	—	588
Yellow Sand	8	—	40	Sandy Lime	588	—	593
Yellow and Gray Sand	40	—	118	Black Shale	593	—	620
Gray Slate	118	—	130	Gray Lime	620	—	668
Gray Lime	130	—	156	Sand	668	—	744
Gray Sand	156	—	238	Dark Slate and Shells	744	—	768
Gray Slate	238	—	245	Gray Sand	768	—	795
Gray Lime	245	—	285	Gray Slate and Shells	795	—	864
Gray Sand	285	—	325	Gray Lime	864	—	895
Gray Slate	325	—	330	Gray Sand	895	—	920
Gray Lime	330	—	446	Gray Slate and Shells	920	—	938
Gray Slate	446	—	455	Gray Sand	938	—	969
Gray Sand	455	—	497	Red Rock	*969	—	1040
Gray Sand and Lime	497	—	555	Gray Slate	1040	—	1087

Formation	*Top*	*Bottom*
Red Rock	1087	1143
Gray Slate	1143	1175
Red Rock	1175	1208
Gray Slate and Shells	1208	1238
Red Rock	1238	1295
Gray Slate	1295	1330
Red Rock	1330	1388
Gray Slate and Shells	1388	1412
Red Sand	1412	1427
Red Rock	1427	1437
Gray Slate and Shells	1437	1473
Gray Sand	1473	1486
Gray Slate and Shells	1486	1607
Gray Lime	1607	1612
Gray Slate and Shells	1612	2161
Red Rock	2161	2180
Gray Slate and Shells	2180	2226
Dark Lime	2226	2246
Gray Slate and Shells	2246	2260
Red Rock	2260	2272
Light Gray Sand	2272	2316
Light Gray Slate and Shells	2316	2370
Light Brown Lime	2370	2386
Light Brown Sand	2386	2420
Gray Sandy Lime	2420	2450
Gray Slate and Shells	2450	2660
Gray Sandy Lime	2660	2683
Dark Sand	2683	2761
Gray Slate and Shells	2761	2795
Dark Brown Sand	2795	2816
Gray Slate and Shells	2816	2825
Gray Sandy Lime	2825	2880
Gray Slate and Shells	2880	2976
Brown Sand	2976	3015
Gray Slate and Shells	3015	3060
Gray Gritty Lime	3060	3170
Gray Lime and Shells	3170	3570
Gray Slate and Shells	3570	3594
Gray Gritty Lime	3594	3645
Gray Slate and Lime Shells	3645	3740
Gray Limey Shale	3740	3805
Brown Lime	3805	3825
Gray Sandy Lime	3825	3984
Gray Slate and Shells	3984	4010
Gray Sandy Lime	4010	4140
Gray Shale and Shells	4140	4190
Gray Lime	4190	4420
Light Brown Shale	4420	4470
Gray Lime	4470	4485
Gray Shale and Shells	4485	5074
Gray Lime	5074	5080
Gray Shale	5080	5105
Gray Lime	5105	5190
Gray Shale	5190	5217
Gray Limey Shells	5217	5360
Gray Lime	5360	5380
Gray Lime and Shells	5380	5479
Gray Lime	5479	5505
Gray Shells and Slate	5505	5650
Gray Lime	5650	5692
Gray Slate	5692	5700
Gray Lime	5700	5810
Gray Lime Shells	5810	5915
Gray Shale	5915	5930
Gray Lime	5930	6125
Gray Shale	6125	6150
Gray Lime	6150	6190
Gray Shale and Lime	6190	6225
Gray Lime	6225	6228
Gray Shale and Lime	6228	6300
Brown Shale and Lime Shells	6300	6366
Dark Brown Shale	6366	6400
Light Brown Lime	6400	6410
Light Brown Shale	6410	6425
Light Brown Lime	6425	6429
Light Brown Shale	6429	6498
Gray Lime Shell	6498	6510
Gray Shale	6510	6526
Gray Lime Shell	6526	6529
Gray Shale	6529	6550
Gray Lime	6550	6553
Gray Shale	6553	6568
Gray Shell	6568	6574
Gray Shale	6574	6585
Gray Shell	6585	6590
Gray Shale	6590	6604
Gray Shell	6604	6654
Very Light Shale	6654	6665
Gray Silt	6665	6675
Gray Shale	6675	6685
Dark Gray Lime	6685	6800
Gray Shale	6800	6850
Gray Silt	6850	6873
Gray Shale	6873	6905
Dark Brown Shale	6905	7235
Brown Tully Lime	*7235	*7285
Gray Shale	7285	7385
Light Brown Shale	7385	7620
Dark Shale	7620	7704
Dark Silt	7704	7715
Dark Shale	7715	7744
Dark Silt	7744	7750
Dark Shale	7750	7765
Dark Shale	7765	7947
Darker Shale	7947	7990
Dark Tully Lime	*7990	*8038
Gray Shale	8038	8050
Total Depth	8050	

Fresh water at 55′ and 75′.

Gas pockets at 4512′, 7695′ and 8050′.

(*) Sample Study Determinations by R. E. B.

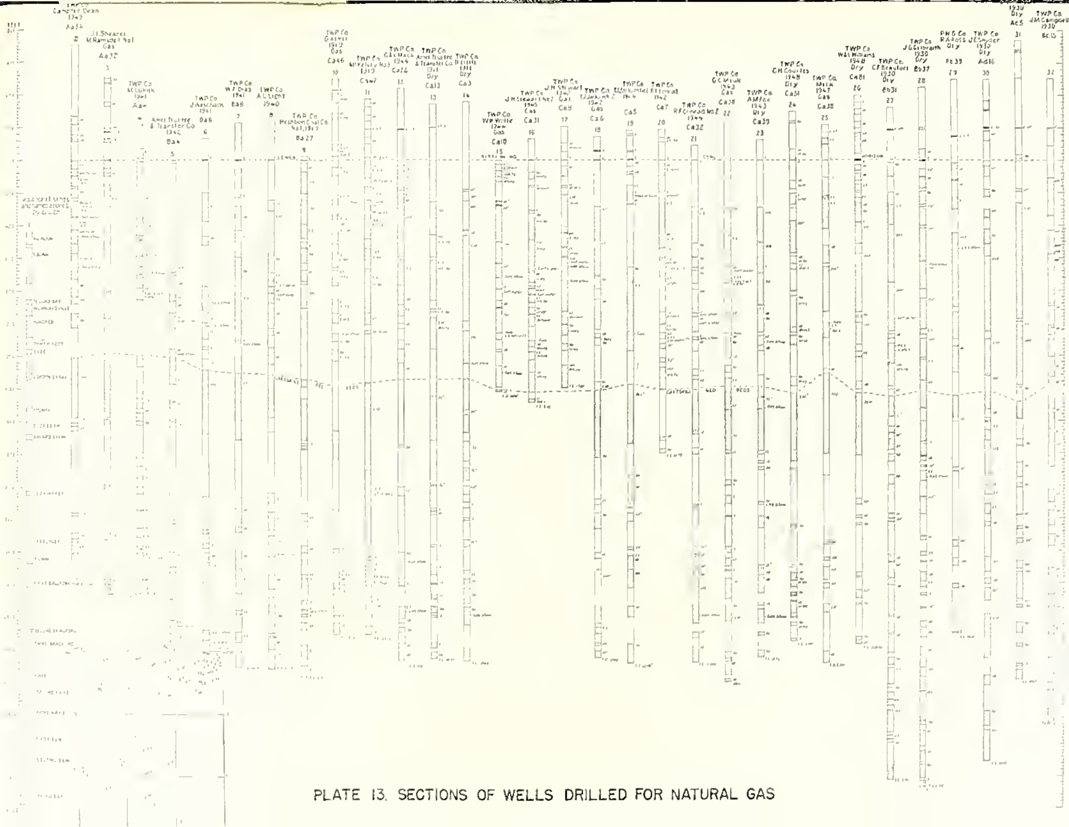

PLATE 13. SECTIONS OF WELLS DRILLED FOR NATURAL GAS

Drillers Log of Camilla F. Griffen No. 2 well (Ab 23)

Formation	Top	Bottom
Yellow Sand	0	40
Gray Sand	40	195
Gray Slate	195	215
Gray Broken Lime	215	235
Gray Sand	235	277
Gray Slate	277	285
Gray Sandy Lime	285	470
Gray Sand	470	518
Gray Slate and Shells	518	544
Gray Sandy Lime	544	558
Gray Slate and Shells	558	595
Gray Sandy Lime	595	630
Gray Murrysville Sand	630	707
Gray Slate	707	715
Gray 100′ Sand	715	770
Gray Slate, Sand and Shell	770	942
Redrock	942	1000
Gray Slate and Shells	1000	1055
Redrock	1055	1150
Gray Slate and Shells	1150	1180
Redrock	1180	1330
Slate and Shells	1330	1348
Sand	1348	1380
Slate and Shells	1380	1420
Sand	1420	1436
Slate and Shells	1436	1830
Sand	1830	1860
Slate and Shells	1860	1920
Sand	1920	1948
Slate	1948	1957
Shell	1957	1967
Slate	1967	1982
Slate and Shells	1982	2188
Red Rock	2188	2212
Sandy Lime	2212	2230
Sand	2230	2262
Slate and Shells	2262	2330
Sand Lime	2330	2360
Slate and Shells	2360	2406
Red Rock	2406	2415
Sand	2415	2470
Slate and Shells	2470	
(Records not complete—Log Book burned)		
Sand	2743	2760
Slate	2760	2791
Lime	2791	2893
Sand	2893	2940
Broken Sand	2940	2996
Sand	2996	3050
Slate and Shells	3050	3198
Sand Shells	3198	3258
Gray Lime	3258	3415
Slate and Lime	3415	3505
Sand	3505	3560
Lime	3560	3780
Slate and Shells	3780	3804
Lime	3804	3904
Slate and Shells	3904	4108
Sandy Lime	4108	4295
Slate and Shells	4295	4340
Sandy Lime	4340	4380
Slate and Shells	4380	4400
Silt	4400	4775
Slate and Shells	4775	4825
Silt	4825	4850
Slate and Shells	4850	4865
Silt	4865	4885
Slate and Shells	4885	5300
Silt	5300	5360
Slate and Shells	5360	5505
Gray Silt	5505	5535
Slate and Shells	5535	5591
Silt	5591	5754
Slate and Shells	5754	5820
Silt	5820	5837
Slate and Shells	5837	5910
Silt	5910	5930
Slate and Shells	5930	6030
Shale and Shells	6030	6107
(Rig burned destroying intervening records)		
Gray Shale	?	6740
Light Brown Shale and Shells	6740	6830
Brown Shale and Shells	6830	6990
Dark Brown Shale and Shells	6990	7165
Gray Shale	7165	7364
Gray Gritty Lime	7364	7381
Gray Shale and Shells	7381	
Total Depth		7467

Did not reach Tully Limestone.

Fresh water at 102′, 215′, 265′ and 1330′.

Clay and Shale

The New Florence quadrangle contains abundant clay and shale resources. They occur in the Conemaugh, Allegheny and Pottsville series. The clays in the Conemaugh series are generally impure; shales suitable for brick making may be available in some localities. Clays in the Allegheny and Pottsville series underlie the coal beds or coal horizons. These underclays are of value in the manufacture of fire brick, or buff face brick. Flint clay associated with plastic clay is present at Bolivar. Red-burning brick shales may also be available. Clay on the flood plains of the larger streams is unimportant. Clay and clay products have been produced in the quadrangle at Bolivar. Clay products are still being manufactured, but the raw material is shipped in from outside this area. The shale resources have not been exploited.

Definitions and Properties

Clays underlying the coal beds are known as underclays. They commonly are bluish gray to dark gray and occasionally carbonaceous. They are structureless and have a smooth, soapy feel. Some exhibit slickensides, caused by movements in the clay mass during compaction and later crustal movement. Underclays are called fire clays by miners, but all clays are not fire clays, and the usage has become more restricted to refractory plastic clay and flint clay which is nonplastic. Underclay is generally plastic clay.

Flint clay is a name applied to a relatively hard, non-plastic clay which breaks with a smooth, conchoidal fracture like flint or fine-grained limestone. It commonly is light gray in color and weathers buff. It occurs as underclay, either as a definite bed or as part of a bed of plastic clay, and often occurs as lenses in plastic clay. Unlike plastic clay it does not weather to a soft, incoherent mass, but retains its flint-like character until reduced to powder. It may be too siliceous or too ferruginous to be of value, but usually it is pure and more refractory than the plastic variety. Flint clay being nonplastic must be mixed with a plastic clay to form a bond.

Mineralogy of Clay

The Mineralogy of clays is an expansive subject. For a full study on clay mineralogy the reader is referred to the excellent recent work of Grim (1953).

Production of clay in the New Florence quadrangle has been inactive for many years, and the workings are inaccessible. However, data concerning the character of the clays was recorded in earlier reports whose authors had direct access to these data. (Leighton and Shaw, 1932, Stevenson, J. J., 1878, Platt W. G., 1877.)

Considerable information on the clay beds is revealed in the records of core drill holes (Plates 2, 3, 4), but this information is largely subsurface, and since the primary objective was to test the coals, the clays are categorically logged as fire clays, and little attention was given to the quality; some clays are indicated as being impure. Core drill records do show that the thickness of clay beds varies from place to place, but it is probable that workable deposits of good quality clay are present in some localities. Natural outcrops rarely reveal the true character of a clay. It commonly crops out as a slumped mass of bleached, white material. Large quantities of underclay are uncovered in coal strip pits. Only the top of the clay is observed, but good quality clay may be available in workable deposits. The position of the underclays in the Allegheny series may be determined by the outcrop lines of the coal beds as shown on Plate 1.

Bolivar District

Production of clay and manufacture of clay products was at one time an important industry along the Conemaugh River at Lockport, Bolivar and Robinson. The Garfield Refractories Company at Robinson is the only plant presently manufacturing brick, but the raw material is obtained from near Gallitzin in Cambia County.

Clay was discovered at Bolivar by James Glover in 1842 or 1843 and the first fire bricks were made by him and transported to Pittsburgh on the Old Pennsylvania Canal. Robinson and Benny established a plant in 1857; Reese Hammond and Company were established in 1867; and later the Garfield Fire Clay Company, the Enterprize Manufacturing Company, The Bolivar Brick Company, and the Lincoln Fire Brick and Shape Company were organized. When Hopkins' report was published (1898), the following firms were operating in the district; Reese-Hammond and Company, Garfield Fire Clay Company, Lincoln Fire Brick and Shape Company, James Gardner, Jr. (at Lockport), and David Coulter (a clay mine). The Joseph Soisson Fire Brick Company, the McFeeley Brick Company, and the Garfield Refractories Company were established later. Fire brick, paving brick, and building brick were made. Clay from Blue Ball and South Fork in the Johnstown area was used in addition to local clay.

Bolivar fire clay. Bolivar is the type locality of the Bolivar fire clay, which is referred to in the geologic reports describing the members of the Allegheny series. The clay occurs below the Upper Freeport limestone horizon at Bolivar; the top of the clay lying about 11 feet below the base of the Upper Freeport coal. It averages about 5 feet of flint clay. This clay contains nodules of iron carbonate (siderite) called "iron balls," which had to be sorted out. Where they are too abundant the clay is worthless. The whole clay bed ranges from 3 to 12 feet thick, including varying amounts of plastic and flint clay. Old workings on the Bolivar clay are located on the hill east of Bolivar (Bb 12). Most of the best clay is reported to be worked out.

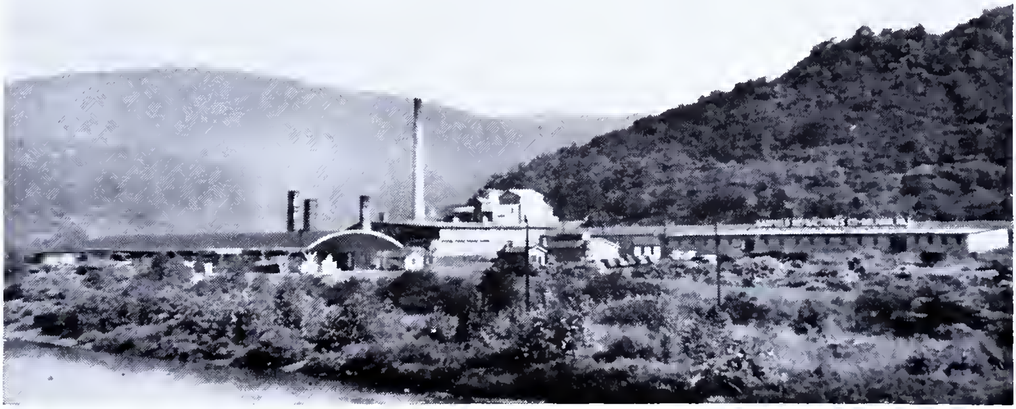

FIGURE 13. Garfield Refractories Company at Bolivar.

Tests of the Bolivar clay made by Shaw (1928) indicate that it is a no. 2 flint clay and fuses at cone 29. Analyses of the clay are given below. Nos. 1 and 2 represent the flint clay, No. 3 the plastic clay. Nos. 1 and 3 are taken from Report H_4.

Analyses of Bolivar flint clay

	1	2	3
SiO_2	50.84	53.24	59.83
Al_2O_3	30.74	32.85	24.58
Fe_2O_3	3.31	2.61	1.65
TiO_2	1.26	.86	1.17
CaO	.16	.63	.28
MgO	.28	.82	.87
Alk	.54	.55	3.11
Ignition loss	13.05	8.34	7.83
MnO		.15	
SO_3		2.86	
P_2O_5		.18	

Lower Kittanning clay. The Lower Kittanning clay was mined in a slope near the plant of the McFeeley Brick Company east of Bolivar (Bb 14) and in a drift at the Garfield Refractories Company plant west of Robinson (Ba 10). The clay is reported to average about 10 to 12 feet thick. The upper 2 feet containing plastic and better quality clay than the remainder but the lower portion is not as sandy as in many localities. Shaw classes the upper clay as no. 3 fire clay, and two samples taken from the lower portion he classes as face-brick clays. Clays taken from the upper, middle and bottom zones all fuse at cone 26. As indicated by the analyses, this clay is more siliceous than the Bolivar clay, the silica ranging from 54.99 to 69.92 percent. The alumina content ranges from 16.83 percent in the middle or more siliceous layer, to 28.45 percent in the lower portion. These clays are used in the manufacture of common brick. Considerable reserves of this clay are believed to be still available in the locality.

Mercer clay. The Mercer clay was mined in an abandoned drift on the west side of Tubmill Creek at Bolivar (Bb 11). The section shows 5 feet of plastic clay underlain by 4 feet of sandy shale, which in turn is underlain by 8 feet of plastic clay. The upper bench fuses at cone 32 and contains 32.71 percent alumina. It is classed as a no. 2 fire clay and is used in the manufacture of fire brick. The lower bench is of about equal rank, its upper half fusing at cone 32 and its lower half at cone 26. The alumina content is respectively 27.65 and 19.96 percent.

Upper Freeport clay. Upper Freeport clay was reported to have been mined along with its overlying coal, in the McFeeley Brick Company "E" mine east of Bolivar (Bb 13), where at the pit mouth of the mine, 5 feet of fairly good plastic clay is exposed. It was also reported that this clay was similarly mined in the Garfield no. 1 mine north of Robinson (Bb 5); the thickness there is uncertain. The Upper Freeport clay is at least 3 feet thick and of good quality where it is exposed at the pit mouth of the Climax no. 1 mine at Lockport (Bb 24).

The following tables showing physical and chemical properties of clays was taken from J. B. Shaw (1928).

Properties of clays in Green State

Sample No.	Water of plasticity percent of dry weight	Shrinkage Water percent of dry weight	Pore water percent of dry weight	Time of slaking minutes	Drying shrinkage percent of dry volume
38	24.85	10.05	14.80	5½	18.29
39	23.31	7.41	15.9	3	13.40
40	24.40	7.57	16.85	7	13.52
41	24.99	8.18	16.81	4½	14.72
42	21.61	5.80	15.82	4	9.85

Burning Shrinkage
Figures represent volume shrinkage in percent of dry volume

Sample No.	Degrees Centigrade								
	1000	1050	1100	1150	1200	1250	1300	1350	1400
38	4.54	8.16	8.13	12.91	19.64	19.86	20.00	19.43	19.43
39	5.26	9.52	9.92	11.12	14.88	20.42	21.13	10.52	8.26
40	3.13	. .	9.88	12.98	. .	19.82	22.25	20.34	19.00
41	3.53	8.60	7.07	9.85	. .	19.75	23.00	18.90	12.05
42	9.75	9.44	9.94	9.98	12.74	12.48	11.07	12.85	10.63

Porosity
Figures represent percent porosity in terms of burned volume

Sample No.	Degrees Centigrade								
	1000	1050	1100	1150	1200	1250	1300	1350	1400
38	30.8	. .	31.4	30.4	. .	18.3	19.2	7.9	3.7
39	32.9	29.0	31.2	29.5	. .	19.7	14.9	14.9	10.5
40	30.6	. .	30.5	28.7	. .	15.5	12.4	9.1	5.4
41	28.1	28.1	30.7	27.9	. .	13.7	8.1	8.5	10.4
42	38.2	39.1	38.9	37.9	37.5	35.5	36.6	37.4	37.5

Apparent Specific Gravity

Sample No.	Degrees Centigrade								
	1000	1050	1100	1150	1200	1250	1300	1350	1400
38	2.52	2.61	2.64	2.73	2.40	2.53	2.56	2.24	2.11
39	2.66	2.61	2.68	2.66	2.23	2.61	2.46	2.19	2.02
40	2.51	. .	2.65	2.69	. .	2.46	2.45	2.31	2.20
41	2.44	2.57	2.62	2.61	. .	2.43	2.40	2.47	2.16
42	2.69	2.71	2.71	2.68	2.74	2.62	2.65	2.70	2.66

Chemical Analyses

	Sample Numbers				
	38	39	40	41	42
Loss on ignition	10.22	8.55	7.90	9.37	8.34
SiO_2	53.62	54.99	58.38	63.56	53.24
Fe_2O_3	.52	1.92	2.88	4.71	2.61
TiO_2	..	1.64	1.19	1.05	.86
Al_2O_3	32.71	28.45	27.65	19.96	32.85
CaO	.21	.50	.41	.87	.63
MgO	.29	..	1.08	.46	.82
Na_2O	..	..	.20	..	.23
K_2O	..	..	.31	..	.32
MnO	.24	..		.02	.15
SO_3	..	..	.15	.17	2.86
P_2O_5	..	..	.085	.03	.18

Sample no. 38 Mercer clay ½ mile west of Robinson. Clay is 8 feet thick, gray unoxidized, has no surface stain, and is a homogeneous mass.

Sample no. 39 Lower Kittanning clay from Garfield mines ½ mile west of Robinson. Clay is 12½ feet thick, the sample being taken from the lower 6½ feet of the bed; it is gray, unoxidized, has no surface stain and is homogeneous in benches.

Sample no. 40 Mercer clay, same location as no. 38. The clay is hard, tough and coarse, unoxidized, gray, and has no surface stain. It is a stratified homogeneous mass, and is the bottom 8 feet of a 17-foot bed.

Sample no. 41. Mercer clay, obtained on the bank of the Conemaugh River west of Robinson. It consists of 5 feet of plastic clay underlain by 4 feet of shale and under this is 8 feet of plastic clay from which sample no. 40 was obtained. Sample no. 41 from the bottom 4 feet of the deposit. The clay is unoxidized, has no surface stain and is homogeneous.

Sample no. 42. Bolivar flint clay from east of Bolivar.

Other clays. A bed of fair quality clay, about 12 feet thick, containing scattered iron carbonate concretions was exposed in a pit below the Garfield no. 1 mine north of Robinson (Bb 4). This clay lies between the Lower Freeport and Upper Kittanning coal horizons.

The Mahoning coal, 12 inches thick at Lockport (Bb 22), is underlain by 13 feet of gray to greenish gray clay of doubtful quality. The interval of about 40 feet up to the Brush Creek limestone is filled with greenish and dark shales. North of New Florence, the Brush Creek limestone and coal are both present (Bb 27), and are underlain by at least 6 feet of gray, plastic clay.

Torrance District

The Lower Kittanning and Mercer underclays may be of value where the Allegheny and Pottsville series crop out in the area about Torrance. These clays are exposed in the railroad cut east of Torrance. The Lower Kittanning clay is 16 feet thick; it is light gray and contains a calcareous concretionary zone. Nine feet of carbonaceous shale separates the clay from the coal bed.

The Mercer clay is 9½ feet thick; the upper 5 feet is light gray and the lower 4½ feet is dark gray. Shaw reports that it has good plasticity and has a low green strength. It fires pinkish buff to gray and has a firing range of 1100 to 1250 degrees C. It fuses to cone 26 and is therefore to be classed as a low-grade fire clay. Its best use would be for manufacture of buff face brick.

The Upper Freeport underclay is reported to be 5 feet thick in this locality, but is impure. The clay is uncovered where the coal was strip mined north of the railroad (Aa 52).

Seward District

The Allegheny series is below drainage in most of this district. It crops out, however, on the side of Laurel Hill. Records of core drill holes indicate variable thicknesses of underclays (Plates 2, 3, 4). The Lower Kittanning and the Lower Kittanning rider clays are fairly persistent and range up to 12 feet thick. An outcrop east of Boltz on Pa. Route 711 shows Lower Kittanning clay 5 feet thick.

Blacklick Creek District

Rocks of the Allegheny series are exposed on the valley sides of Blacklick Creek from Josephine eastward to the boundary of the quadrangle. The Pottsville is above the creek on the Chestnut Ridge and Nolo anticlines.

Many years ago clay was dug in open pits east of Josephine (Aa 10) and used for brickmaking in a plant nearby. The clay was locally called the Blacklick; it lies below the Lower Kittanning coal. The section obtained by Platt (1876) which is given below, shows the Lower Kittanning and the Mercer clays.

Section east of Josephine

	Feet
Lower Kittanning coal	4
Clay	12
Ore Shale	3
Poor Fire Clay	5
Sandstone	40
Brookville coal (?) (Mercer)	3
Shale and Clay	10-20
Sandstone	5
Hard Clay	3-5
Sandstone	1
Plastic Clay	3½
Sandstone	

Subsurface information on the clays south and west of Blacklick is shown on Plates 2, 4 and the area about Heshbon on Plate 3. The Lower Kittanning clay merits investigation where the coal has been strip-mined extensively near Dias. The Mercer clay is 16 feet thick where it is exposed on the railroad east of Dias (Ca 28) but it is impure.

Chestnut Ridge

Underclays are indicated where the Upper Freeport and Lower Freeport coals have been strip-mined on Chestnut Ridge between Blacklick Creek and the Conemaugh River, but information concerning the clays was not obtainable.

SHALE

The best grade of shale for making common brick and tile products is clay shale, which generally is buff or red, and does not have a gritty feel; it burns to a red color. Clay shales are present in the Monongahela, Conemaugh and Allegheny series of rocks, and usually are associated with limestone. Red shales may alternate with buff and greenish shales. They are restricted to the Conemaugh series mostly in the middle and upper parts. Red shales alternate with minor green shales in the Mauch Chunk series, but contain too many sandy beds to be of value. Black shales commonly overlie the coal beds especially in the Allegheny series. They are usually too highly carbonaceous and practically worthless for brick making or other uses.

The shale resources in the quadrangle have not been exploited, nor are they known to have been tested. Field observation was limited to partial, unweathered outcrops. Some good clay shales are indicated locally, but the extent and thickness sufficient to constitute a deposit of economic value is problematical. Vertical and lateral gradation to sandy shales is not uncommon. However, concentrated exploration in certain favorable localities, probably would reveal workable deposits of useful shales. The following localities are suggested for exploration.

Ligonier Syncline

Northwest of Old Colony (Ac 22), clay shale in the lower part of Monongahela series is about 15 feet thick. Red and buff shale in lower part of Conemaugh series west of Mellons (Bb 21), west of Ross Mountain Park (Bc 1, 2) and north of Ross Mountain Park (Cb 21).

Latrobe Syncline

Upper Conemaugh red shale and clay north of Campbells Mill (Aa 1, 20), and east of Campbells Mill (Aa 23). Core drill records in the Latrobe syncline show thick deposits of red and light shales in the Upper part of the Conemaugh series (Plate 2, sections 1-6).

LIMESTONE

Limestone occurs at fairly regular intervals in the rocks cropping out in the New Florence quadrangle. Limestone has been quarried and mined at various places, but is a minor resource without commercial importance, with one exception.

Uses of Limestone

The ensuing descriptions on the uses of limestone is brief and restricted to uses which apply to the limestones in this area. For a more complete description on the uses of limestone the reader is referred to B. L. Miller's report on the Limestones of Pennsylvania (1934).

Crushed stone. Crushed limestone is used for railroad ballast, road metal and concrete aggregate. The physical properties of the rock determine its suitability for these uses. It should be hard, tough, durable and break into angular fragments. The Loyalhanna fulfills these requirements; it has been quarried extensively and very large quantities of crushed stone have been produced. A detailed discussion of the Loyalhanna is presented later.

Some of the other limestones in the quadrangle probably would also meet these requirements, but they are too thin to constitute a quarry rock.

Structural stone. For use in foundations and walls of buildings, a limestone should have regularly-spaced fracture planes so that it quarries out into blocks of suitable size and shape; resistance to weathering is also an important factor. Most of the limestones in this area have fairly regular joint systems and commonly have thin shale partings. The color of the fresh surface is light to bluish gray, but they weather buff or light brown in a relatively short time. The Loyalhanna limestone breaks out into various sizes and shapes, and the fracture is uneven. It has been used for facing for buildings. Its hardness, toughness, and resistance to abrasion, fit it for use as paving blocks. Paving blocks have been made from the Loyalhanna limestone. They are shaped by hand and called "Belgian" blocks by the trade.

Lime. The essential chemical properties of limestone for making agricultural lime is a high content of calcium and magnesium. Limestone high in silica, alumina and iron oxide is difficult to burn and requires handling larger quantities of material. Analyses have not been made of any of the limestones in the New Florence quadrangle. The freshwater limestones are relatively impure and make only fair quality lime.

The limestones are too limited in thickness and distribution to be of any commercial interest for agricultural lime. Due to the proximity of coal, they have had some minor importance in making lime for local agricultural use. The rock was benched along the outcrop or mined with the coal bed in drifts. Some lime was produced in upright kilns, but it was largely burned in open heaps built up of alternating layers of limestone and coal. Since better and cheaper commercially produced lime for agricultural fertilizer became available from the outside, these methods of producing lime are little practiced in this area.

Flux. In general, the suitability of a limestone for use as flux depends almost entirely upon its chemical composition: it should be low in silica and alumina. Although the limestones in the New Florence area are argillaceous, they have been used for flux in the past in local iron furnaces. Some of the local iron ores occurred as secondary replacement in limestone, constituting an ore with flux.

Cement rock. Because of the argillaceous content, some limestones are called cement rock, and natural cement has been produced from them at places outside this area. The Johnstown Cement bed or Upper Kittanning limestone was noted for this purpose. This limestone is only present locally in the quadrangle. Portland cement has entirely replaced natural cement and revival of the Johnstown limestone as a cement rock is unlikely.

Stratigraphic and Areal Distribution of Limestones

The Monongahela strata are the highest in the quadrangle containing limestone. The lower part of these strata underlies small areas in the Latrobe and Ligonier synclines. The Conemaugh series is widely distributed in the Latrobe and Ligonier synclines. It contains numerous beds of limestone, but they usually are thin and discontinuous; the thicker and more persistent beds are found in the upper part. Limestone is locally present under the coal beds in the Allegheny series which crops out mostly as irregularly-shaped bands on the limbs of Chestnut Ridge and Laurel Hill anticlines and on the sides of some of the stream valleys. Rocks of the Pottsville series do not contain limestones in the quadrangle. The Mississippian system contains the valuable Loyalhanna siliceous limestone; the Greenbrier limestone is also included in this system. It is a fairly pure and important limestone south and southwest of this area, but it is thin or missing here and has not been worked.

Adequate description of the limestones in the Monongahela, Conemaugh and Allegheny series is given in the foregoing discussion headed "Stratigraphy." Because of the economic importance of the Loyalhanna siliceous limestone it merits special consideration which is given in the succeeding discussion.

Loyalhanna Limestone

Stratigraphic position. The Loyalhanna (siliceous) limestone is Mississippian in age and lies between the base of the Mauch Chunk red beds and the top of the Pocono. These are the lowest rocks exposed in the New Florence quadrangle.

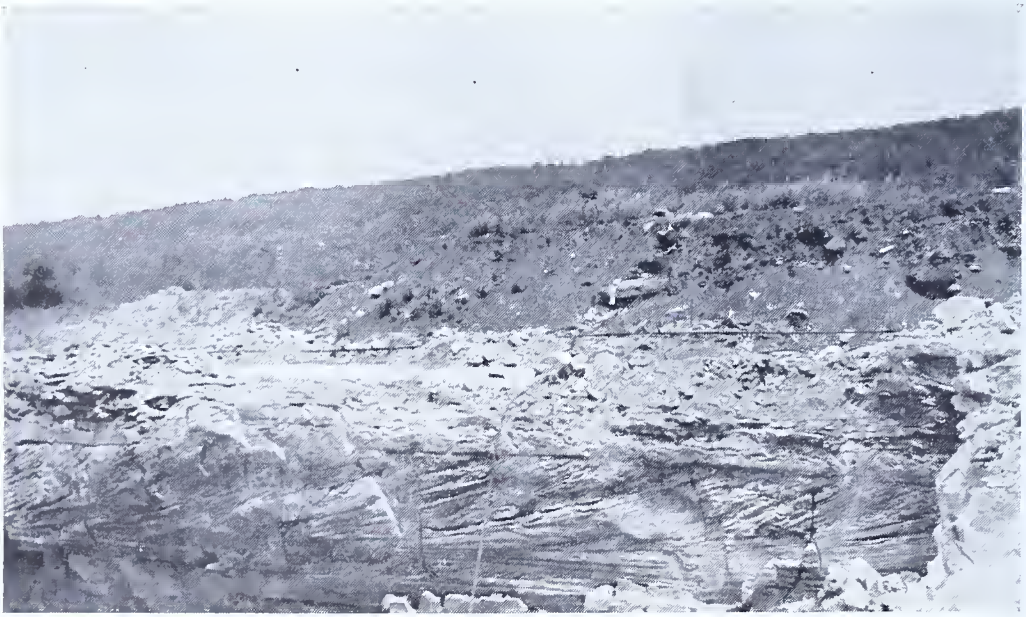

Figure 14. Cross-bedding in upper part of Loyalhanna limestone.

Character and mineralogy. The Loyalhanna ("Blue rock") is commonly described as a limestone, but it could also be properly described as a calcareous sandstone. It is a massive rock consisting of grains of quartz cemented by calcium carbonate. It is bluish to greenish gray on the fresh surface and weathers light gray or buff. Crossbedding is a characteristic feature of the Loyalhanna. It is scarcely discernible on the fresh surface, but becomes strikingly conspicuous where a surface has been exposed long enough to emphasize the inequalities of the individual beds. Due to differential solution, the resistant laminations of the topset and forest beds stand out with rounded edges, and more soluble ones have grooved edges. Some edges are alternately iron-stained, which further emphasizes these features.

Hickok (1940 p. 458) has studied thin sections and insoluble residues of samples of the Loyalhanna in Fayette County, and he states as follows: "The rock is composed predominantly of quartz grains and calcitic oolites cemented by calcite. It contains also a few rounded grains of crystalline calcite. The quartz grains, which range from 1 mm. to .01 mm., are distinctly frosted, and although distinctly subangular their points are rounded. Although all grain sizes between the limits mentioned above are found in the Loyalhanna, individual specimens are composed of grains falling into one or two size groups of narrow limits. If only one size of grain occurs in the specimen commonly it is within the limits .10 to .05 mm.; where grains of two sizes are present, the larger grains commonly lie within the limits of .5 to .2 mm.; a few specimens showing grains larger than .5 mm. have a lower limit of .3 to .4 mm. for course grains. The fine-grained part in these specimens ranges from .50 to .02 mm., but in few cases grains as small as .01 mm. were seen.

All the quartz grains do not appear to come from the same source. Most are uncrystalline quartz which has sharp extinction under crossed nicols. Others show undulatory extinction similar to that which is produced by strain, and still others show a multicrystalline structure similar to that found in recrystallized quantities. Some of the quartz grains, quite irrespective of the types mentioned above, contain considerable dark staining material thought to be limonite. This stain is related to individual grains and not to areas in the rock and so must have been acquired by the quartz before deposition in the Loyalhanna. Some quartz grains contain minute needles of apatite and one was seen which included zircon crystals; both minerals indicate an igneous source for this quartz.

Calcite grains and oolites are common in the Loyalhanna. The siliceous and calcareous content is quite variable and in rock which has a low siliceous content, oolites are abundant. The oolites commonly are so stained with opaque material that the crystallinity of the calcite is not apparent, but in a few cases a radial structure was observed. Oolites are present in all thin sections of the rock but are abundant only in material that has been less than 40 percent of insoluble residue. Rounded grains of clear unicrystalline calcite are present in some thin sections. The grains do not look like oolites but rather appear to be calcite sand grains which have been included in the detritus that accumulated during the formation of the rock.

Besides the quartz and calcite mentioned above, tourmaline, biotite, chlorite, feldspar, olivine (?) and black opaque mineral grains were observed. The matrix cementing the grains of the rock is calcite in all the thin sections studied. In a few cases the calcite is contaminated with clayey material from partly altered biotite. Commonly, however, it is fairly pure and coarsely crystalline. None of the thin sections show silicification of the cement, although field examination of some of the material indicates the complete silicification of carbonate in parts of the upper part of the formation. The great variation in the calcareous content of the rock is due to the relative abundance of granular and oolite calcareous material and not to variation in the cement."

Distribution and thickness. The outcrop of the Loyalhanna limestone is confined to Laurel Hill and Chestnut Ridge where these anticlines have raised it to the surface. The crop line forms irregular narrow bands as delineated on Plate 1. Normally, the dips on the limbs of these anticlines range from 8 to 12 degrees, but in the fault zone on the east limb of Chestnut Ridge south of the Conemaugh River, dips up to 85 degrees have been recorded. North of the Conemaugh River, the northeast plunging axis of the Chestnut Ridge anticline takes the Loyalhanna below the surface. The horizon of the Loyalhanna is above Blacklick Creek where the axis of the anticline crosses, but for reasons stated on page 45, it is believed that this formation is missing. The thickness of the Loyalhanna in the quadrangle ranges from about 40 to nearly 70 feet.

Commercial development. The Loyalhanna limestone is not presently being quarried in the New Florence quadrangle. There have been at various times 11 quarries producing Loyalhanna limestone; 4 of these quarries were large scale operations with crushing and sizing plants. The product was used for railroad ballast, road metal, and aggregate for concrete; some paving blocks ("Belgian blocks") were also produced. There are doubtless other reasons for abandonment of these operations, but in some instances it is apparent that overburden had reached the economic limit of removal in the locality with the capability of the equipment in use; spoiling of overburden appeared to be an additional problem in some cases. Transportation facilities to these sites is excellent and extensive reserves are available. With the development of modern, powerful earth-moving machines capable of removing great thicknesses of overburden, it is possible that these abandoned projects could be profitably reactivated and additional ones developed.

The Loyalhanna limestone crops out on thousands of acres of marginal wastelands on Laurel Hill and Chestnut Ridge and the reserves of this resource are practically unlimited. The overlying Mauch Chunk ranges from about 130 to 200 feet thick and is predominantly composed of shales with some relatively weak interbedded sandstone. The thickness of this overburden is progressively reduced by erosion on the spurs of the mountain sides upward toward the crests.

Demand and production of crushed stone has increased at a steady rate and is expected to continue. In 1942 Pennsylvania produced 6,767,810 tons at a value of $7,148,191; in 1952 the production had increased to

13,254,633 tons at a value of $19,160,967. The increase in production of crushed stone is due largely to extensive construction of highways of modern design calling for thicker base courses, wider pavements, improved shoulders and other structure; all requiring still larger quantities of crushed stone. With development of modern highways construction specifications for crushed stone have become more complex in requiring greater variety of sizes and grades.

Analyses. Analyses of the Loyalhanna limestone in the quadrangle are not available. Chemical and physical analyses have been made of the Loyalhanna in Fayette County (Hickok and Moyer 1940) and the minimum, maximum and average of seven chemical and 12 physical analyses are given below. The general physical characteristics of the Loyalhanna have a wide regional similarity and it could therefore be expected that the chemical and physical properties of the Loyalhanna in the New Florence quadrangle will fall within these maximum and minimum ranges.

Chemical analyses of Loyalhanna Limestone

	Minimum	*Maximum*	*Average*
SiO_2	21.46	50.95	39.29
Al_2O_3	1.96	3.71	3.04
Fe_2O_3	.60	1.56	1.15
$CaCO_3$	41.73	74.82	54.31
$MgCO_3$	.56	2.80	1.0

Physical analyses of Loyalhanna Limestone

Sp. gr.	2.63	2.69	2.68
Weight lbs./cu. ft.	164.1	174.2	167.4
Absorption	0.22	1.65	.46
Percent wear	2.2	3.9	2.7
French coefficient of wear	10.2	18.2	15.1
Toughness	8	22	14

Quarries. All of the commercial and most of the custom quarries in the quadrangle are located on Chestnut Ridge; all are presently inactive.

On the north side of the Conemaugh River southeast of Strangford (Aa 53), a large quarry was operated by John J. Ryan of Pittsburgh. The company shipped crushed stone for railroad ballast and produced about 1,500 paving blocks per day. The stone in the basal part is said to be better suited for making paving blocks, but the reason is not known.

The limestone is 60 feet thick in the high wall of the quarry which is about 600 feet long. Overburden in this locality increases from zero at the outcrop to from 40 to 80 feet thick at a distance of 100 feet into the hillside. The gradient of the outcrop is about 15 percent, or rises at the rate of 15 feet per 100 feet distance to the east.

Booth and Flynn Packsaddle quarry is located well up on the west side of Chestnut Ridge south of the Conemaugh River. The Loyalhanna was quarried in two separate operations. One (Ab 1) extends for about 2,000 feet along the east side of a ravine, the other (Ab 5) is about 1,500 feet long and is near the top of the ridge. The quarried rock was hauled on a tramway down the east side of a ravine to a crushing and sizing plant located on siding from the main line of the Pennsylvania Railroad. It is reported that the plant had an annual output of 40,000 tons.

The Loyalhanna ranges from 60 to 67 feet thick in this locality and very large reserves are easily accessible for further development. The outcrop of the limestone extends for great distances, cropping out below the crest of the ridge. The gradient is variable but generally moderate. Thickness of overburden generally increases at the rate of from 10 to 30 feet per 100 feet in from the outcrop.

Jones' quarry is on Brides Run east of Grays (Ab 6). This operation terminated in 1940. A siding from the main line of the Pennsylvania Railroad extends 1½ miles up to the quarry; the crushing and sizing plant is about one-half mile from the railroad. The quarry is about 1,300 feet long and 200 feet wide. Several drifts, on 150-foot centers, were driven in from the face of the quarry and about 25 feet of the lower part of the limestone was mined. Trucks were backed into the drifts and the rock was hauled to the plant.

The Loyalhanna is 60 feet thick in this locality. Quarrying operations could be extended for more than a mile along the outcrop upward to a saddle or the crest of the ridge. About a mile of outcrop is also available on the hillside to the south. Overburden increases at the rate of from about 25 to 40 feet per 100 feet in from the outcrop.

Gray's quarry is on Hillside Run (Ab 13, 14) about 1.2 miles from the main line of the Pennsylvania Railroad, from where a siding extends up to the quarry. The Loyalhanna was worked in two main operations; a small quarry is located farther up the run (Ab 15). The quarry on the north side of the run is about 650 feet long and 150 feet wide; the one on the south side of the run has approximately similar dimensions. An accurate thickness of the Loyalhanna was not obtainable but it is estimated to be about 60 feet thick. These workings could be extended for considerable distances farther along the outcrop. Amount of overburden is similar to that in the Jones' quarry.

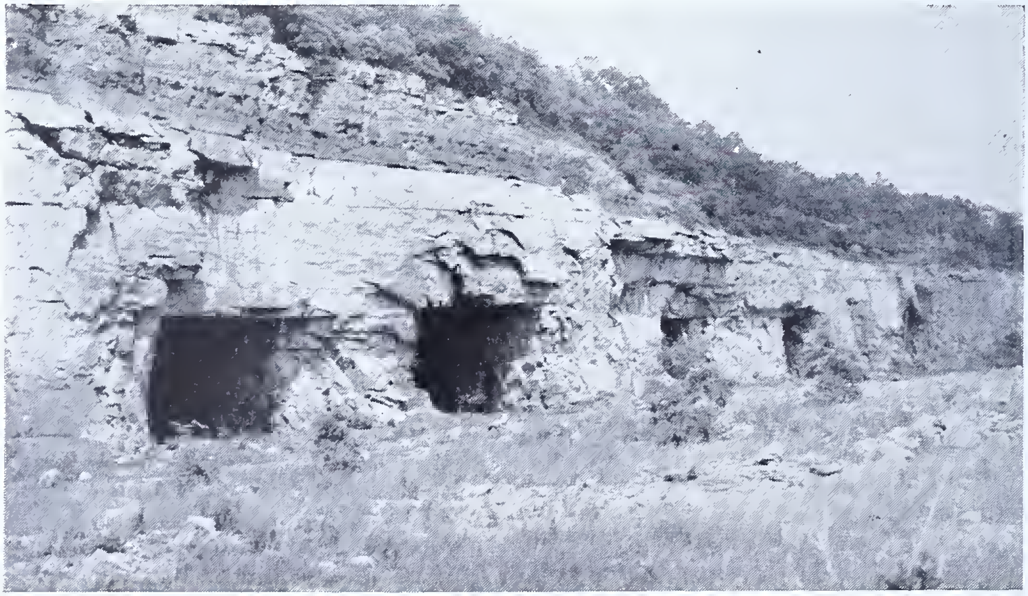

FIGURE 15. Loyalhanna limestone, Mauch Chunk red beds above, Gray's quarry south of Torrance.

Small custom quarries on the east side of the Chestnut Ridge are located west of Shawley School (Ac 1) southwest of Bolivar (Ab a), west (Ab 2, 3) and north (Ab 1) of Bolivar. A small quarry is located on the east side of Laurel Hill just north of Pa. Route 271 (Cc 7).

SANDSTONE

Uses of Sandstone

Sandstone suitable for many uses is widely distributed and occurs in practically unlimited quantities in the New Florence quadrangle. Some sandstones are over 50 feet thick. The sandstones are thin- to thick-bedded, slabby and flaggy, fine- to coarse-grained and conglomeratic; shale partings are common. Colors are whitish, light to dark gray and greenish. Scattered mica flakes are common particularly on the bedding planes of the finer-grained sandstones. Fracture planes usually are not too well developed. Sandstone has been worked only in a minor way in the quadrangle, mostly for local use for rough masonry and basal road course stone; some dimension stone has been produced.

Building stone and flagstone. The main requirement of a sandstone for use as building stone and flagstone is its physical characteristics; chemical properties are a factor only if they affect the ability of the stone to resist weathering. Sandstones usually have sufficient strength for most uses. For building walls the stone should be resistant to weathering and the fracture should be at approximately right angles to produce blocks of fairly regular size and shape; uniform color is also a desirable feature. Stone for rough masonry and foundations need not necessarily meet the above requirements. Hardness is an important factor in flagstone since it is subjected to considerable abrasion. The stone also should split out into slabs of desirable thickness, and at least one side should be fairly smooth.

Crushed stone. Like building stone and flagstone the requirement for crushed stone is mainly physical. The chemical constituents are important only if they affect the physical characteristics of the rock. Since crushed stone is broken into small angular pieces, the larger fracture planes are unimportant. Bedding planes, however, must be so spaced that when broken, the greater dimension of the pieces is no more than five times the least dimension. If crushed stone is to be used for highway surfacing, whether the bond is cement or some bituminous bond, the Pennsylvania Department of Highways, in their physical hardness and strength tests, specify a percentage wear of less than 5 and a toughness of more than 6.

Base course stone. The requirement for base course stone is similar to that for crushed stone as explained above, except that for secondary roads the requirements are for less strength and a percentage of wear of 7 or 8 is allowed as well as toughness of only 3 or 4.

Glass sand. Glass sand has not been produced in the quadrangle, but Pottsville sandstone had been quarried for glass sand on the west flank of Chestnut Ridge, northeast of Derry (Fettke 1919) in the Latrobe quadrangle. Pottsville sandstone of similar quality was noted on Chestnut Ridge in the New Florence quadrangle.

The chemical composition of a sandstone for a good quality glass sand is the important requirement. Silica (SiO2) is the important constituent of glass sand. All glass sands contain impurities, the main ones being Al_2O_3, Fe_2O_3, MgO, CaO and TiO_2. These impurities are permissible in varying small quantities. Fettke (1919) gives a detailed discussion on permissible impurities in glass sand.

Grain size is the only physical character of importance. When sandstone is crushed it commonly breaks into particles approximately the size of the sand grains in the original sandstone. After crushing, most of the grains should pass through a 30-mesh screen and remain on a 120-mesh screen. The reason for this is based on the processes which are used in making glass, since particles not passing through the 30-mesh screen would be so large that they would not mix well with the other ingredients of the glass mix, and not melt well when heated, whereas particles passing the 120-mesh are so fine that they would tend to blow away in most glass furnaces.

Silica refractories. Silica refractories have not been produced in the quadrangle. Brick and granular sand are produced from Pottsville sandstones in Fayette County (Hickok and Moyer 1940, p. 488). Raw materials used in refractory products are quartzites and dense conglomerates. Pottsville sandstone at places in the quadrangle approximates these materials and probably would serve for refractory use. Detailed discussion on the chemical requirements of silica refractories is given by Moore and Taylor (1924 pp. 17, 18). A brief summary is as follows.

SiO2 is the main constituent and must comprise over 96 percent.

Fe_2O_3 must be less than 2 percent.

$A1_2O_3$ less than 1.5 percent.

Alkalies less than 0.5 percent each.

Sandstone Locations

Sandstones occur at various positions throughout the stratigraphic section and have a wide distribution in the quadrangle. The stratigraphic and areal distribution of sandstones is discussed in detail under the foregoing section headed "stratigraphy."

Following are descriptions of sandstone quarries and selected outcrops, with respect to geographic districts, where sandstones are available for various uses.

Ligonier Valley. A minor quantity of flagstone was obtained from a small quarry on the hill north of Myers School (Ac 21). The sandstone lies above the Pittsburgh rider coal. It is fine-grained and micaceous, and iron-stained on the bedding planes; a thickness of 6 feet is exposed.

The Connellsville sandstone in the upper part of the Conemaugh series was worked for rough masonry in a small quarry east of Wilpen (Ac 24).

Road metal was quarried from the Connellsville sandstone west of Fort School (Bc 11). About 15 feet of the deposit is exposed. It contains slabby beds in the upper part with shale partings but thick beds in the lower part would yield dimension stone. Large quantities of this rock are available in the locality. The hard resistant character of this sandstone is indicated by weathered-out boulders that cover the surface near Shawley School.

Dimension stone for construction of Hillview Furnace was obtained from the Morgantown sandstone in a quarry near the furnace (Ac 25). The rock is gray, hard, medium-grained and iron-stained on the joints and bedding planes. About 15 feet is exposed showing slabby beds in the upper part and thick beds in the lower part. The Morgantown sandstone is about 40 feet thick in this locality.

The Saltsburg sandstone is a hard, medium-grained, gray, slabby rock where it was quarried near Waterford (Bc 27). Although only about 15 feet of the sandstone is exposed, it is at least 25 feet thick and extensive in this locality. It would be suitable for road metal or rough masonry. A small quarry in the same sandstone is located west of West Fairfield (Bb 35), where the rock is light gray to whitish, medium-grained, hard and about 35 feet thick. Thin beds in the upper part grade downward to thick, massive beds in the lower part. The stone would be useful for road metal, rough masonry and dimension stone.

Another quarry in the Saltsburg sandstone is located northwest of West Fairfield (Bb 33). Here, fine-grained, greenish-gray, thin-bedded sandstone at the top grades downward to thick, gray, coarse-grained beds at the bottom which contain scattered small quartz pebbles. The quarry was worked for material for township road construction. The deposit is about 40 feet thick and suitable for various purposes such as road metal and rough masonry. This sandstone is extensive in the locality and makes bold outcrops on the hillsides south of Factory School (Bb 31a, 32).

The Mahoning sandstone which lies above the Upper Freeport coal is well developed and crops out on the hillsides about Bolivar, Robinson and Lockport. The sandstone has a known maximum thickness of 50 feet. It is generally a light colored, hard, medium-grained rock with slabby beds in the upper part and massive beds in the lower part. Large quantities of good stone probably are available. The Mahoning sandstone is also well developed at Ross Mountain Park.

A sandstone overlying a coal bed which is considered to be the Lower Kittanning rider coal was worked in a small way for some local use on Baldwin Creek south of New Florence (Ca 20). The exposed thickness of the deposit is 40 feet. The rock is gray, slabby, fairly hard, and contains thin ribbons of limonite. It might furnish reasonably good road metal.

Laurel Hill. The Homewood and Connoquenessing sandstones in the Pottsville series generally are hard resistant rocks where they crop out on the sides of Laurel Hill. They are exposed over wide areas where the weaker overlying Allegheny rocks have been removed by erosion. The Homewood is gray to whitish, medium-grained and massive. It may have pebbly lenses in the lower part, and limonite may appear as concretions of fillings of fracture planes. The deposit is normally about 30 feet thick. Locally, it is composed of nearly pure quartz sand and probably possesses the essential chemical requirements of a glass sand of good quality. The rock is useful for various structural purposes.

The Connoquenessing sandstone in some respects is similar to the Homewood, but it tends to be coarse-grained and more conglomeratic. At some places it approximates silica refractories material. Normally, the deposit is about 25 feet thick. In the Johnstown quadrangle (Phalen 1911) west of Seward, the Connoquenessing sandstone shows the following analysis.

Analysis of sandstone from near Seward

SiO_2	97.54
Al_2O_3	.81
Fe_2O_3	.09
MgO_1	.06
CaO	1.04
Na_2O	.02
K_2O	.16
H_2O at 100	.03
Ignition loss	.49

A large quarry in the Homewood sandstone on Hulls Run southeast of Ross Mountain Park (Cc 2) produced the material for construction of the nearby rock dam at Tubmill Reservoir. The sandstone is light gray to whitish, medium-grained and contains infrequent lenses of scattered quartz pebbles. Minor limonite is present as concretions and fracture-plane filling. Upper slabby beds grade downward to thick massive beds at the base.

The Homewood and the Connoquenessing sandstones are well displayed where they crop out on Shannon Run; the Homewood makes a bold Bluff at least 30 feet high on the south side of the run. Partial outcrops of these sandstones are observable almost continuously along the west side of the mountain, and the spurs are covered and the ravines filled with float or naturally quarried rock.

The Pottsville sandstones are generally similar in character and crop out on the east side of Laurel Hill. An active quarry (1950) in the Homewood is producing crushed stone north of Pa. Route 271 (Cc 3). About 25 feet of the sandstone is exposed in the quarry wall; the lithology of the rock is similar to that in the quarry on Hulls Run.

In the Pocono series, about 200 feet below the base of the Loyalhanna siliceous limestone, there is a medium-coarse-grained conglomeratic whitish, massive sandstone with a maximum thickness of 70 feet. This hard, resistant rock forms the crest of Laurel Hill. Its character is similar to that of the Connoquenessing sandstone, and may easily be mistaken for it.

A greenish-gray, fine-grained sandstone 6 to 8 feet thick occupying a position in about the middle part of the Mauch Chunk series is apparently persistent in this area. It is quarried for flagstone on the south side of Laurel Hill just south of Pa. Route 271 (Bc 29). The rock breaks out along smooth bedding planes in slabs up to 3 inches thick and 36 inches in largest dimension. The quarry covers about an acre and is worked part time to supply local trade.

Chestnut Ridge. The Pottsville sandstones on Chestnut Ridge generally fit their description at Laurel Hill. These rocks crop out over large areas and very large quantities are available. The Homewood sandstone was formerly quarried extensively for glass sand by the American Window Glass Company near Derry and by the Derry Glass Sand Company near Millwood. These quarries are situated near the main line of the Pennsylvania Railroad and are near the boundary of the Latrobe and New Florence quadrangles. A full description of these operations is given by Fettke (1919).

The Homewood sandstone is particularly well developed and is a fairly pure quartz sandstone at various places on the west side of Chestnut Ridge. Intensive investigation may reveal workable deposits of good glass sand.

SAND AND GRAVEL

The relatively recent deposits of sand, gravel, and mixed alluvium occurring on flood plains of the larger streams are indicated on Plate 1 by the symbol "Qal." These deposits are generally thin and have doubtful economic value. The only known use of these materials is northeast of New Florence (Cb 15), where a deposit of loam 6 feet thick was recently dug for furnace lining and for sealing furnace doors.

IRON DEPOSITS

The iron industry in the New Florence quadrangle began early in the 19th century and flourished until a little beyond the middle of that century, declining after the discovery of hematite ore in the Mesabi range in Minnesota in 1852. Today some of the furnaces still stand as well preserved relics of that industry. The pits from which the iron ores were dug are now largely concealed. The iron deposits are sedimentary in origin and consist mainly of carbonates which have been oxidized into limonite or brown iron ore at the outcrop. The iron carbonate (Siderite) occurs as scattered nodules of concretions embedded in clay and shale, and is common in the roof shales of coal beds. Iron carbonate occurs as partial replacement of limestone. Residual limonite nodules usually mark the weathered limestone outcrops. The stratigraphic position and areal distribution of limestones are described in the foregoing section headed "Stratigraphy." Minor hematite is present; particularly as a concentration in the weathered zone at the base of the Mauch Chunk red beds where they crop out on the limbs of Laurel Hill and Chestnut Ridge. Red beds in the Conemaugh series contain scattered nodules of hematite. Although these lean iron deposits in the quadrangle and elsewhere in western Pennsylvania at one time constituted an ore of iron, they are not in quantities sufficient to be of present economic value now nor in the foreseeable future.

Historic Account

The following account of the history of the iron industry is taken largely from J. J. Stevenson (1878) descriptions.

The early furnaces used charcoal; coke was introduced sometime after 1836. The iron industry as a whole was not very successful. Local supplies of ore were limited and soon exhausted, necessitating bringing ore from distant sources. Most of the product was transported to markets by water in time of flood, which was uncertain. In many instances advantages of a favorable turn in the market were lost, and when the iron was delivered, the price had dropped to the point whereby the return was hardly enough to pay the cost of production and transportation. Only those with large capital could afford to hold their product for favorable market prices. The financial crash of 1836 and 1837 forced many weaker concerns out, and some of the stronger ones stopped voluntarily.

Hermitage Furnace. The Hermitage Furnace was the first in the quadrangle. It was built by General Arthur St. Clair in 1802. The site of the furnace is described as being along Mill Creek about two miles from Ligonier which places it somewhere between Oak Grove and Waterford. Some of the ore was obtained from a bed in the lower part of the Allegheny series; most of it was obtained from a bed in the Conemaugh series about 150 feet below the Pittsburgh coal, or at the position of the Clarksburg limestone. The furnace went out of blast in 1810 but was blown in again by General O'Hara in 1816, who, however, ran it for but a short time. The coal used in the Blacksmith shop was packed in sacks from Lockport until 1807, when a violent flood, known as the "Pumpkin Flood" exposed the previously unknown Pittsburgh bed nearby.

Hanna Furnace. Hanna furnace on Tubmill Creek at the base of Laurel Hill was built by a Mr. Benninger in 1810, and soon after he built a forge at Bolivar. Information concerning the furnace and the forge could not be obtained.

Ross Furnace. In 1814, Mr. Meason built Ross furnace on Tubmill Creek, not far from the site of Hanna furnace. A new stack was erected in 1842 by Meason and Matthiat and was kept in blast until 1854 or 1855. Some ores reportedly came from the lower part of the Allegheny series. Limonite in shale above the Upper Freeport was dug on Tubmill Creek south of the furnace (Bc 6). Ore and flux were obtained from the Cambridge limestone in pits along Hendricks Run to the southwest (Bc 16). Under Mr. Matthiat's management the concern was very prosperous; the iron was very good, and much of it was cast into stoves and pots. Ross furnace is standing well preserved today at Ross Mountain Park.

Lockport Furnace. Lockport furnace at Lockport on the Conemaugh River was built by Thomas and William McKennan sometime between 1855 and 1856. Further information could not be obtained.

Laurel Hill Furnace. Laurel Hill furnace still stands intact on Baldwin Run about 1 mile south of New Florence. It was constructed in 1846 by

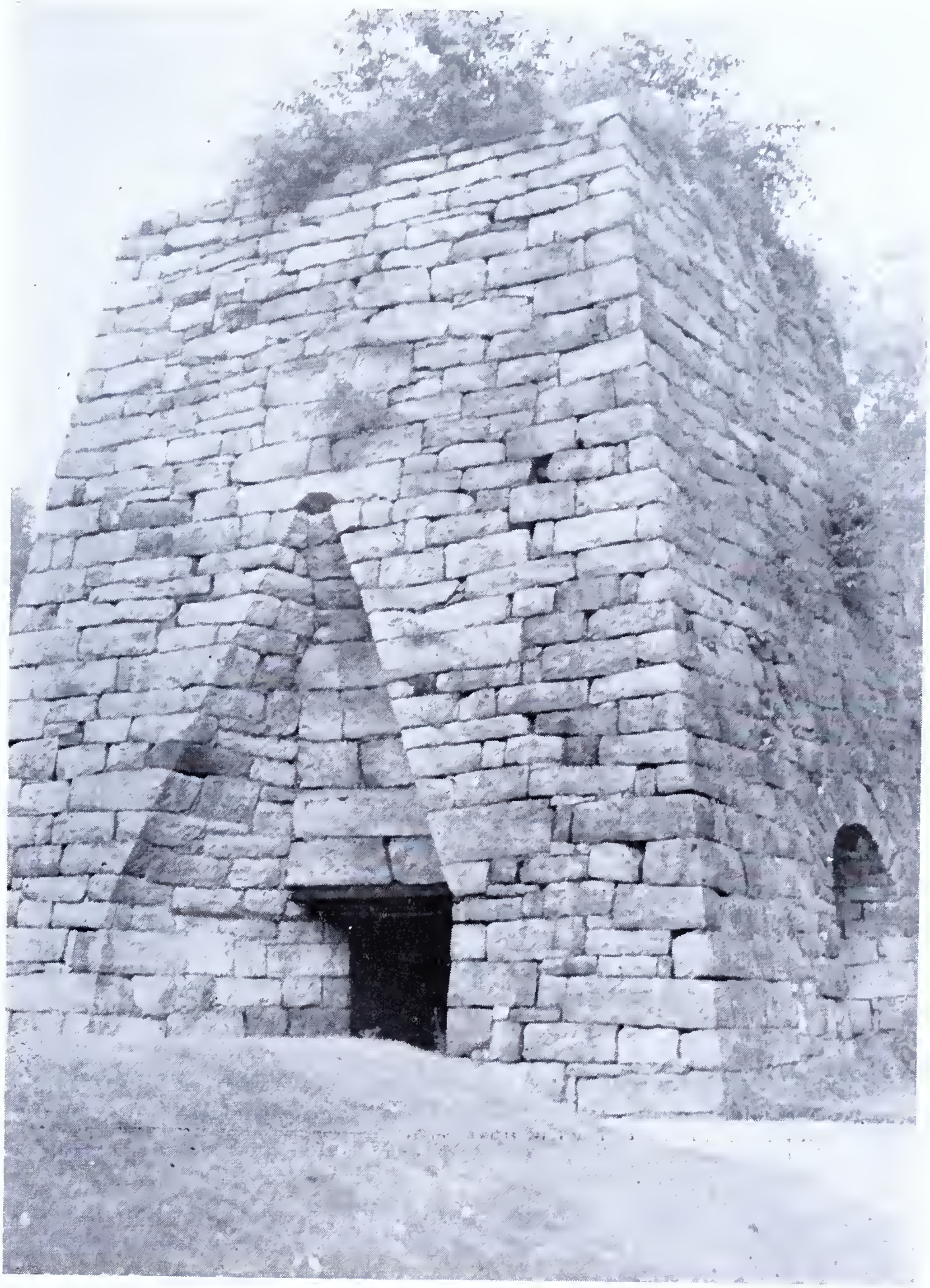

FIGURE 16. Ross iron furnace built in 1814, Ross Mtn. Park.

Hale, Gallagher and Reed. Its weekly output averaged 33 tons. This was one of the first furnaces to utilize the furnace gases for heating the blast. The iron produced was largely converted into castings on the premises.

The furnace went out of blast in 1855, and soon afterward the casting house and several other buildings were destroyed by fire.

Another furnace is still standing about 1 mile farther up Baldwin Run, but nothing is recorded about it. The ore used in these pits was hematite obtained from the basal part of the Mauch Chunk where it crops out on the top of a spur ("Mule Hill") near the crest of Laurel Hill (Cb 22). The partly concealed pits are still visible.

Hillview Furnace. Hillview furnace is located near the school of that name north of Waterford. The furnace is still well preserved. It was built by L. C. Hall in 1850. Pittsburgh coal was coked in ricks (open heap) upon the ground and is said to have proved good. The ore came from a bed 150 feet below the Pittsburgh coal. The furnace was not successful and soon went out of blast.

Oak Grove Furnace. Colonel J. Clifford built Oak Grove furnace in 1854. The site is at the junction of Hanna Run and Mill Creek. It remained in blast for little more than three years. Ore was obtained from a bed about 150 feet below the Pittsburgh coal. The ore is said to be from 1 to 2 feet thick and to be in a solid bed. Following is an analysis.

Iron	28.00
Sulphur	.156
Phosphorus	1.765
Insoluble residue	6.000

The history of the furnace located on the south side of Blacklick Creek near Dias is unknown.

WATER RESOURCES

The New Florence quadrangle has a wide range in the conditions of ground water occurrence. This favorable situation results from the great thickness and extent of the stratigraphic section exposed, the large amplitude of folding and the high topographic relief. Thick sections of permeable beds exposed on the slopes of Laurel Hill and Chestnut Ridge are saturated with water moving down the structural limbs. Surface water is available from the numerous runs and creeks. Some communities are supplied by small reservoirs. Springs, drilled wells and a few shallow dug wells furnish water for domestic purposes.

Precipitation and Run-off

The range in annual precipitation in southwestern Pennsylvania is from 34 to 51 inches and averages about 40 inches. Precipitation is adequate for agriculture. The precipitation records for Pennsylvania are published in detail by the United States Weather Bureau in their monthly and annual Climatological Data.

About 50 percent of the water that falls as rain and snow runs off the surface; 40 percent passes back into the atmosphere, either directly by evaporation from the surface or indirectly in the process of transpiration by plants, and 10 percent soaks into the ground water table. The maximum run-off is generally during March and April. December, January and February have greater than average run-off unless the streams are frozen. Runoff in the summer and fall months is variable and for different years shows higher or lower than average run-off. Gaging-station records are published by the U. S. Geological Survey and the Pennsylvania Department of Forests and Waters. See also Pennsylvania Geological Survey Bulletin WI, 1933.

Ground Water

Ground water is that which sinks into the earth and percolates downward through crevices and pores in the rocks until it reaches either an impervious stratum or the water table. If an impervious stratum, such as a clay under a coal bed, is encountered, the water is blocked in its downward passage and follows down the dip of the bed, eventually emerging at the outcrop as a spring. If, on the other hand, it first reaches the water table, it tends temporarily to raise the level of that table, causing increased out-flow in the valleys where the table intersects the surface. Underground waters have the same direction of movement as surface waters. In a similar way the water table follows the topography of the surface, but its slopes are more gentle. Its height may vary considerably, depending on the rainfall. During a prolonged dry season, the water level may drop beneath the level of the bottoms of shallower wells and they become dry. The position of the water table varies with the character of the surface and of the underlying rock. The water table is nearer the surface in broad, flat areas than near sharp declevities where the water may drain away readily. It is nearer the surface underlain by fine-grained impervious rocks, such as shales, than that underlain by coarse-grained porous sandstone.

Aquifers

Among the formational units, sandstones contain the largest amounts of ground water. The approximate depth to the expected potential water producing horizons can be determined as explained on page 00.

Sandstones in the Conemaugh and Allegheny series commonly are waterbearers where they are well developed and have wide areal extent, but they vary in water-yielding capacity, and grade laterally into shale facies where yields are relatively small. However, water may be expected to occur in at least one of the sandstones, and it may only be a problem of how deep a well must be drilled to encounter water. Sandstones in the Pottsville series have great regional extent. Although locally quartzitic, they generally are permeable and have joint systems, and reportedly yield relatively large quantities of water.

Sandstones in the upper part of the Conemaugh furnish ample supplies of water for moderate use in the deeper parts of the Ligonier and Latrobe synclines. The Morgantown sandstone is particularly extensive and productive of water where it lies below drainage in and near the center of the basins.

Structural conditions in the deeper part of the Ligonier syncline apparently are favorable for wells under artesian pressure, but it is not known if any of the wells are under sufficient pressure to flow at the surface.

Sandstones in the lower part of the Conemaugh series, and those in the Allegheny and Pottsville series lying for the most part below the water table in the deeper parts of the synclines, rise generally into the water table toward the anticlines where they crop out and are recharged on the limbs of those structures. The Upper and Lower Saltsburg, the Buffalo, and the lower and upper parts of Mahoning sandstones in the lower part of the Conemaugh, and the Kittanning sandstones in the middle part of the Allegheny are usually present, and may be expected to contain water in some quantity. The Homewood and Connoquenessing sandstones in the Pottsville series should yield considerable quantities of water. There is a sandstone in the upper part of the Pocono series, which is similar in character to the Pottsville sandstones, and likely would also be water-bearing.

Springs commonly occur along the outcrop of coal beds having some thickness of underclays. Spring water issuing from coal beds may be sulphurous, particularly where a coal bed has been mined. Drilled wells producing from coal beds usually yield potable water. Rocks lying below extensive impervious beds such as underclays may yield little or no water. Minor amounts of water are reportedly produced from limestone beds.

Theoretically, ground water may penetrate as far into the surface of the earth as it is possible for cracks and pore spaces to remain open. Logs of shallow gas wells in the densely drilled areas in Indiana and Jefferson counties indicate that fresh water in appreciable quantities is rarely encountered at depths below 300 feet, and the larger yields are encountered at depths lying between 100 and 200 feet. Wells drilled on or close to drainage levels will produce water at less than 100 feet below the surface. It is therefore suggested that a prospective well be located at the lowest convenient topographic point within the limits of the property.

The logs of gas wells also indicate that salt water is encountered at depths ranging from 800 feet to more than 1000 feet; and from about 600 to 800 feet below the ground water table. Salt water is connate water, or water that was deposited simultaneously with solid sediments, and has not, since its deposition, existed as surface water. Many years ago at some place in western Pennsylvania salt water was produced from wells and after evaporation, yielded an excellent quality of table salt.

Public Water Supplies

The boroughs and smaller communities in the quadrangle are supplied with water by individually or community-owned drilled wells or with surface water from small reservoirs. Domestic supplies in the rural districts are obtained from springs piped by gravity, dug wells and from drilled wells.

Josephine borough is supplied with water from drilled wells owned by the Josephine Water Company. The West Penn Power Company plant at Robindale obtains its water supply from a small reservoir on a nearby run. Seward borough is serviced with water from Big Spring Reservoir at the foot of Laurel Hill. The Pennsylvania Railroad owns Sugar Run Reservoir on Laurel Hill. The Borough of New Florence is supplied from a small reservoir near the head of Baldwin Creek, also on Laurel Hill. The service of Tubmill Reservoir at Ross Mountain Park is not known. Bolivar and Robinson are supplied by drilled wells. Waterford gets its water supply from a small reservoir on Mill Creek.

Water Well Data

Limited data concerning drilled water wells in the quadrangle are obtainable. Reported yields of domestic wells range from about 5 to 25 gallons per minute. Following are drillers' logs of water wells.

Log of Well at Fort Palmer

Material	*Thickness Feet*	*Depth Feet*
Soil	20	0-20
Shale	8	20-28
Limestone (Lower Pittsburgh)	8	28-36
Fire clay	16	36-52
Shale	45	52-97
Shale, sandy	13	97-110
Shale	21	110-131
Limestone (Clarksburg)	3	131-134
Shale, blue-gray, clayey	41	134-175
Sandstone (Morgantown), water to base	75	175-250
Shale, sandy	20	250-270
Limestone (Wellersburg)	5	270-275
Shale, black	8	275-283
Shale, blue-gray	20	283-303
Shale, sandy	8	303-311

The Morgantown sandstone had in flow of 56 gallons per minute, and the water rose to within 80 feet of the surface. The diameter of the well is 8 inches and it was cased to a depth of 25 feet. The total depth is 311 feet. Two other nearby wells drilled to the same horizon have approximate yields of 5 to 25 gallons per minute.

Log of Fairfield Camp Well, about 1.5 miles east of Fort Palmer

Material	*Thickness Feet*	*Depth Feet*	*Water G.P.M.*
Overburden	4	4	
Soft yellow, sand shale	14	18	
Soft, blue fire clay	4	22	
Light blue fire clay	18	40	½
Brown sandstone	14	54	
Dark sandstone	4	58	½-1
Bony coal, trace; fire clay	4	62	
Dark sandstone	6	68	1-2
Sandy fire clay	4	72	5-7
White limestone shale	21	93	3-10
Hard, dark shale (checked water 105)	22	115	2-12
Dark slate	10	125	20-30
Blue sandstone (Morgantown)	8	133	
Blue shale	17	150	
Hard limestone shale	28½	178½	

Capacity of the well is 30 gallons per minute, water static level is 65 feet below the surface. Total depth is 178½ feet.

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GLOSSARY

Because some words in this report may not be familiar, the following definitions are given:

anticline An upfold or arch in the rocks.

areal geology Distribution, position, and form of the areas of the earth's surface occupied by different sorts of rocks.

argillaceous Clayey, applied to rocks containing clay.

cleat Main set of joints along which coal breaks out in mining.

conchoidal To break with concave and convex surfaces.

cyclothem A series of beds deposited during a single sedimentary cycle of the type that prevailed during the Pennsylvania period.

dimension stone Stones that are quarried of required dimensions.

dip The angle at which beds or strata are inclined from the horizontal.

drag fold Smaller folds produced by the shearing stresses set up within a fold by the relative movements of beds along bedding planes.

fault A break or shear on which there has been an observable displacement of the two parts of the mass parallel to the plane of the break. Dip. A fault whose strike is approximately at right angles to the strike of the strata. Strike. A fault whose strike is parallel to the strike of the strata.

fauna The assemblage of the animal forms living in a given place at a given time (modern or fossil).

graywacke A sandstone composed of 33 percent or more of easily destroyed minerals and rock fragments derived by rapid disintegration of basic igneous rocks, slates, and dark colored rocks.

Incompetent beds Not combining sufficient firmness and flexibility to transmit a thrust and to lift a load by bending.

joint A parting plane which separates or tends to separate two parts of a once continuous block.

megascopic Observations made on minerals and rocks by means of the naked eye or pocket-lens, but not with a microscope.

nodule A small roundish lump of a mineral or earth.

oolites Round grains like the roe of a fish.

peneplain A surface of slight relief, formed by the subareial degradation of the land almost to base level.

plasticity The property of a substance whereby it can be permanently deformed without rupture.

road metal Rock suitable for surfacing and for foundations for roadways.

slickensides Polished and grooved surfaces caused by one mass of rock sliding past another as happens in faulting.

strike The trace of the dipping plane on the horizontal. The strike is at right angles to the dip.

syncline A trough; a structurally low point toward which the rocks dip.

unconformity An erosional break in the continuity of sedimentation.

water table The upper surface of a zone of saturation.

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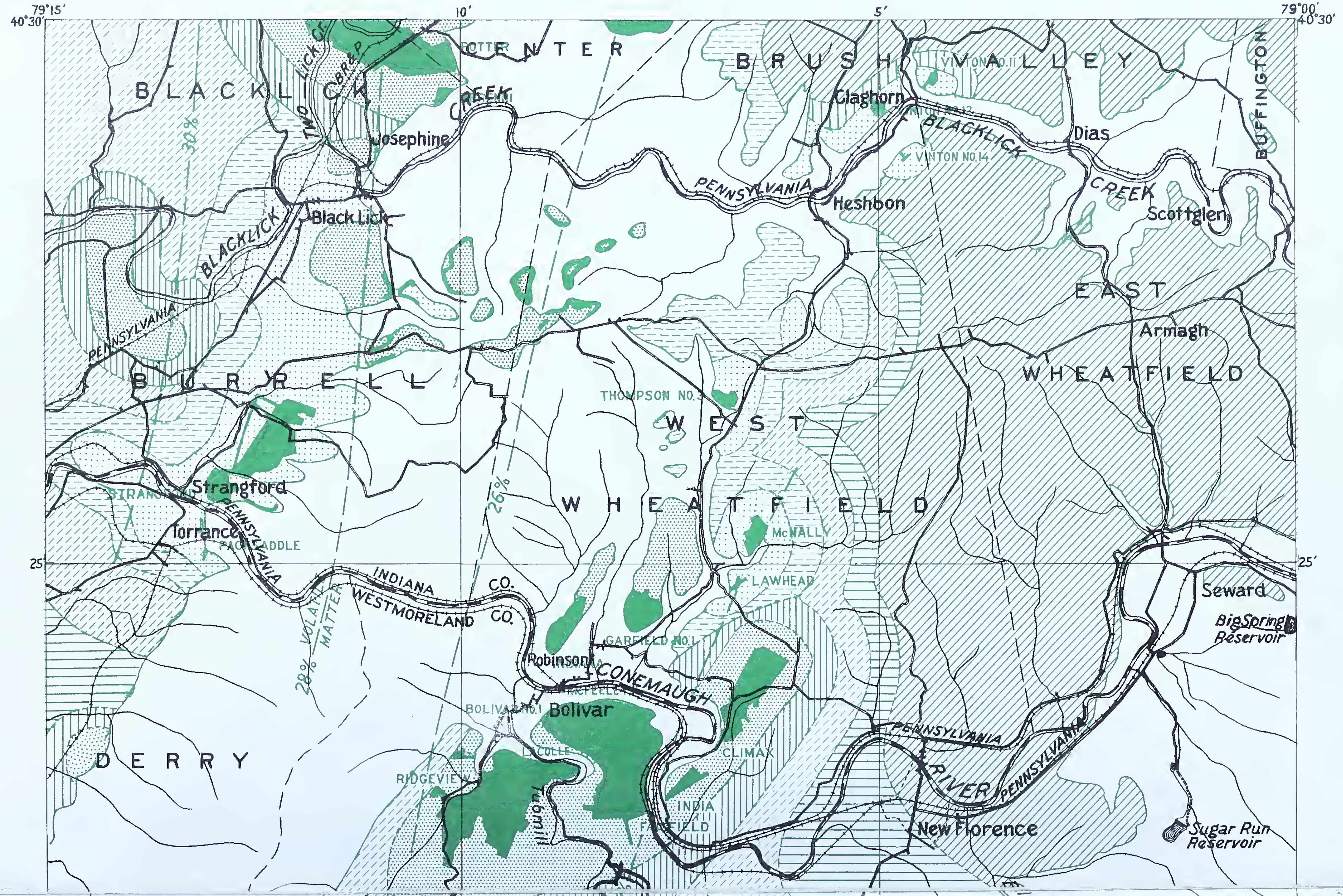

79°15′
40°30′
10′
5′
79°00′
40°30′
25′
25′
BLACKLICK
CENTER
BRUSH VALLEY
BUFFINGTON
POTTER
CREEK
TWO LICK CR.
B.R.&P.
Josephine
Black Lick
BLACKLICK
PENNSYLVANIA
30%
Claghorn
VINTON NO.11
VINTON NO.12
VINTON NO.14
BLACKLICK
CREEK
Dias
Scottglen
Heshbon
PENNSYLVANIA
EAST
Armagh
WHEATFIELD
BURRELL
THOMPSON NO.3
WEST
WHEATFIELD
McNALLY
LAWHEAD
26%
Strangford
STRANGFORD
Torrance
PACK SADDLE
PENNSYLVANIA
INDIANA CO.
WESTMORELAND CO.
28% VOLATILE MATTER
GARFIELD NO.1
Robinson
CONEMAUGH
McFEELEY
BOLIVAR NO.1
Bolivar
LACOLLE
RIDGEVIEW
Tubmill
CLIMAX
INDIA
FAIRFIELD
DERRY
PENNSYLVANIA
RIVER
PENNSYLVANIA
New Florence
Seward
Big Spring Reservoir
Sugar Run Reservoir

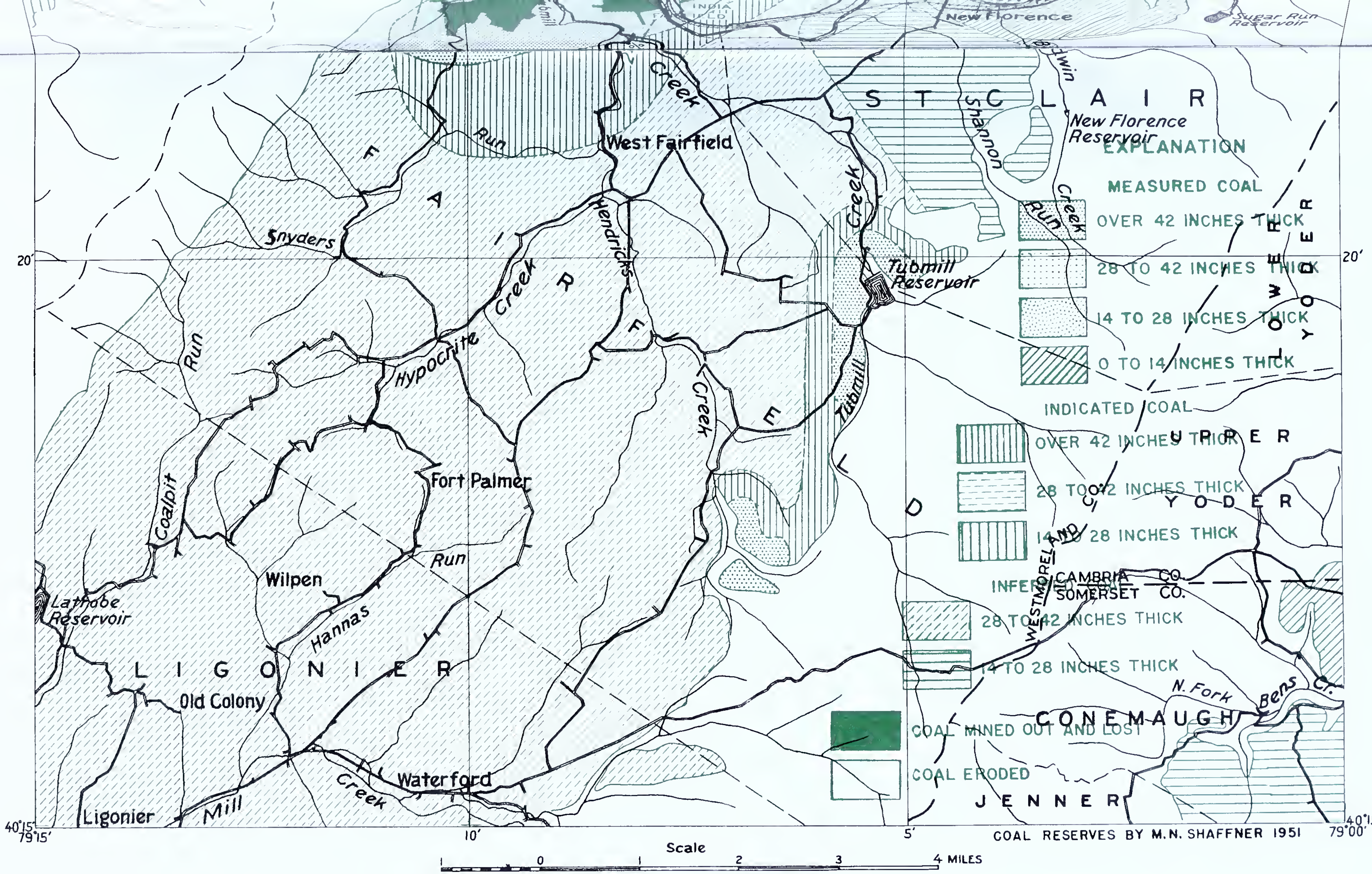
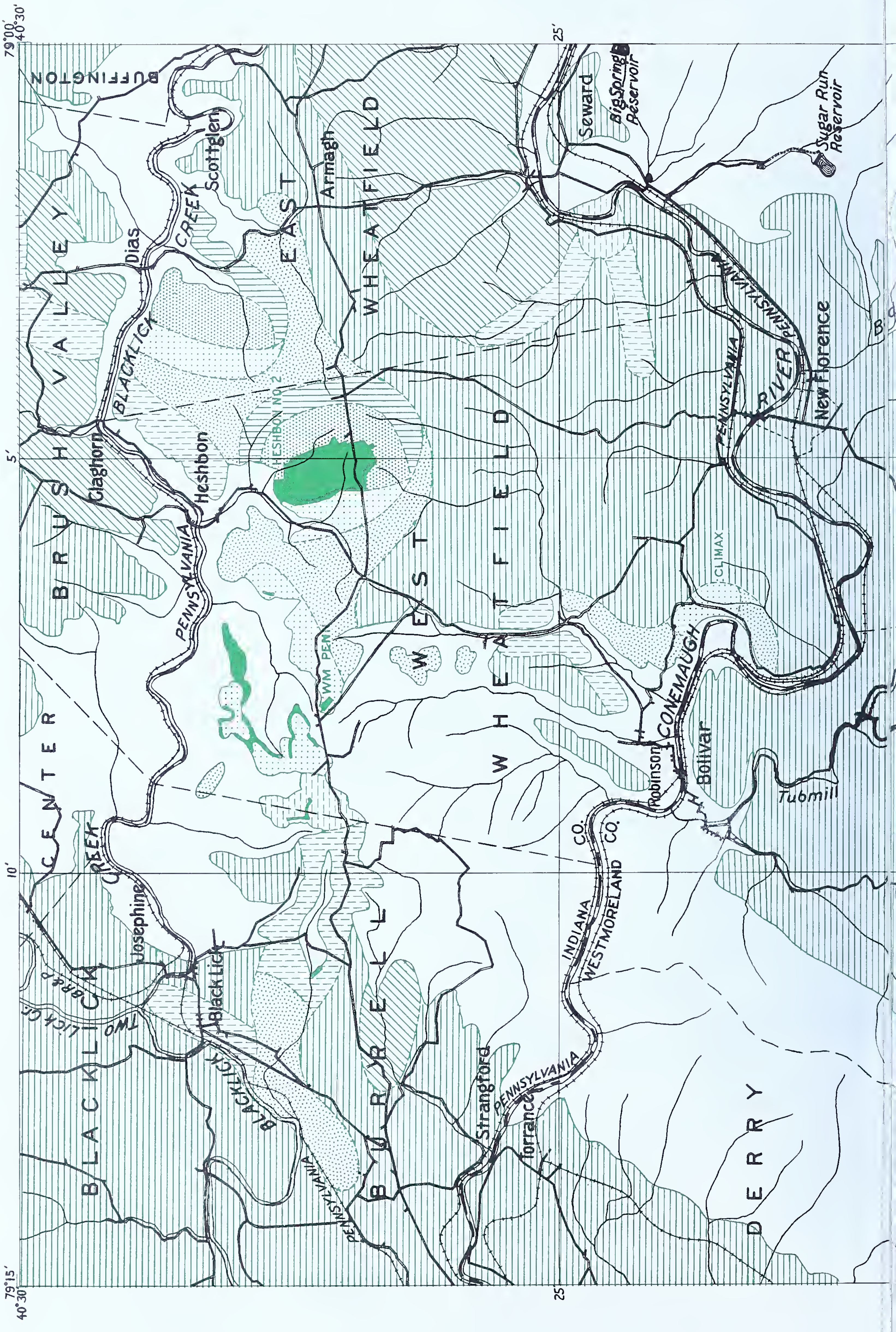


PLATE 9. MAP SHOWING RESERVES OF UPPER FREEPORT COAL


79°00'
40°30'
25'
5'
10'
79°15'
40°30'
25
BUFFINGTON
BRUSH VALLEY
CENTER
BLACKLICK
EAST WHEATFIELD
WEST WHEATFIELD
BURRELL
DERRY
Seward
Big Spring Reservoir
Sugar Run Reservoir
Scottglen
Armagh
Dias
Claghorn
Heshbon
HESHBON NO. 2
WM PENN
CLIMAX
New Florence
Bolivar
Robinson
Tubmill
Josephine
Blacklick
Strangford
Torrance
PENNSYLVANIA
CONEMAUGH RIVER
BLACKLICK CREEK
TWO LICK CR.
B. R. & P.
INDIANA CO.
WESTMORELAND CO.
B

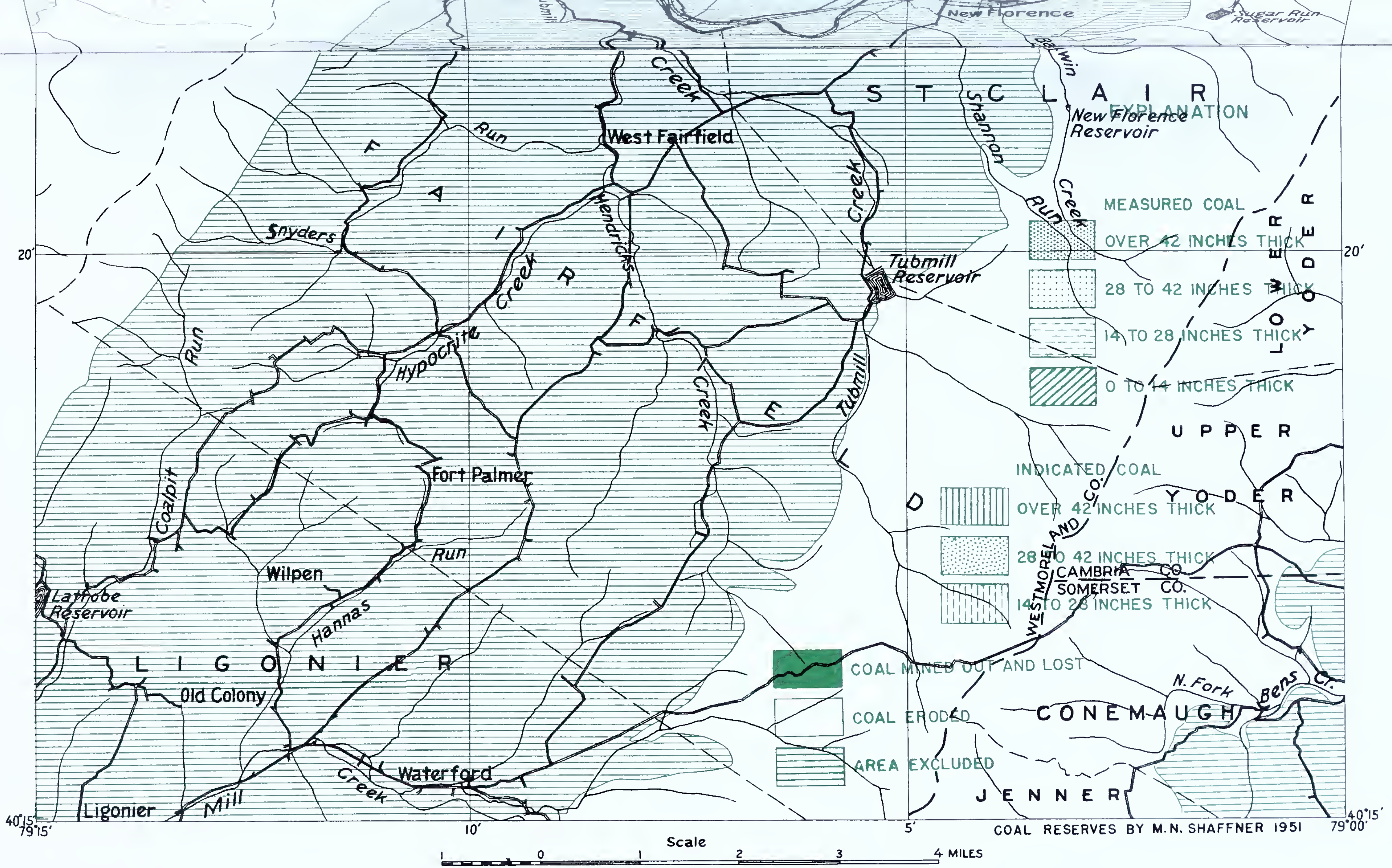


PLATE 10. MAP SHOWING RESERVES OF LOWER FREEPORT COAL

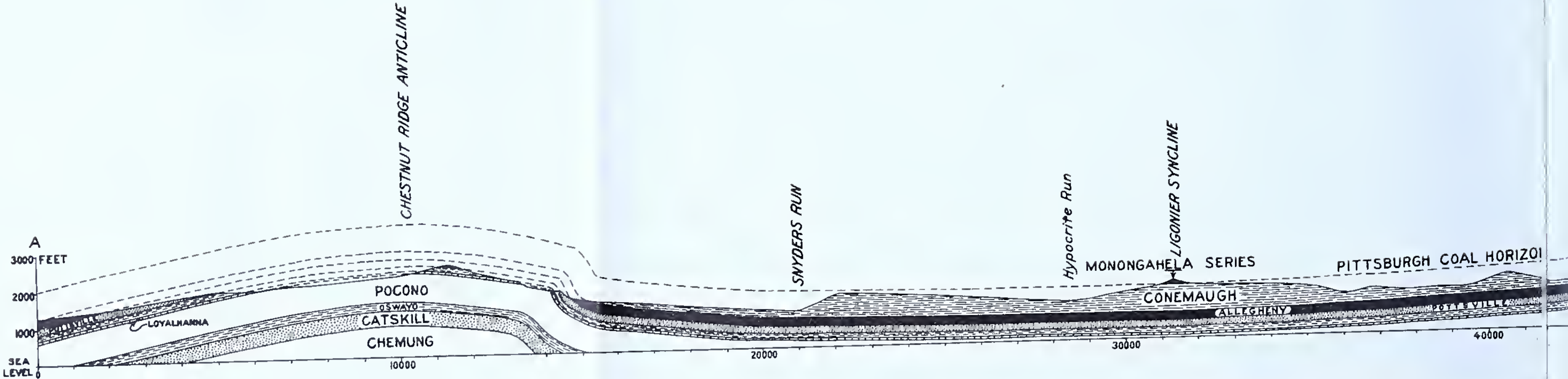
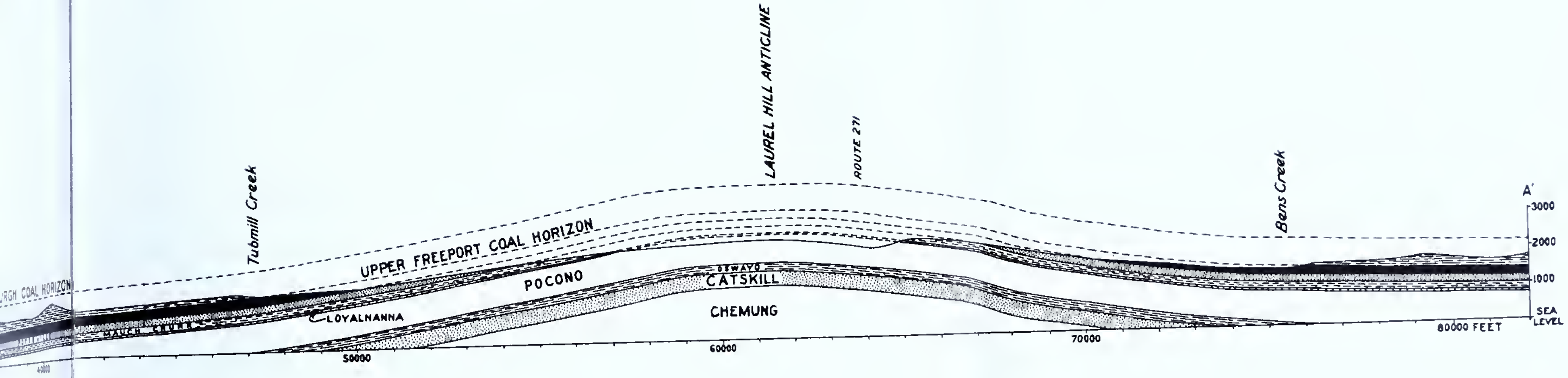
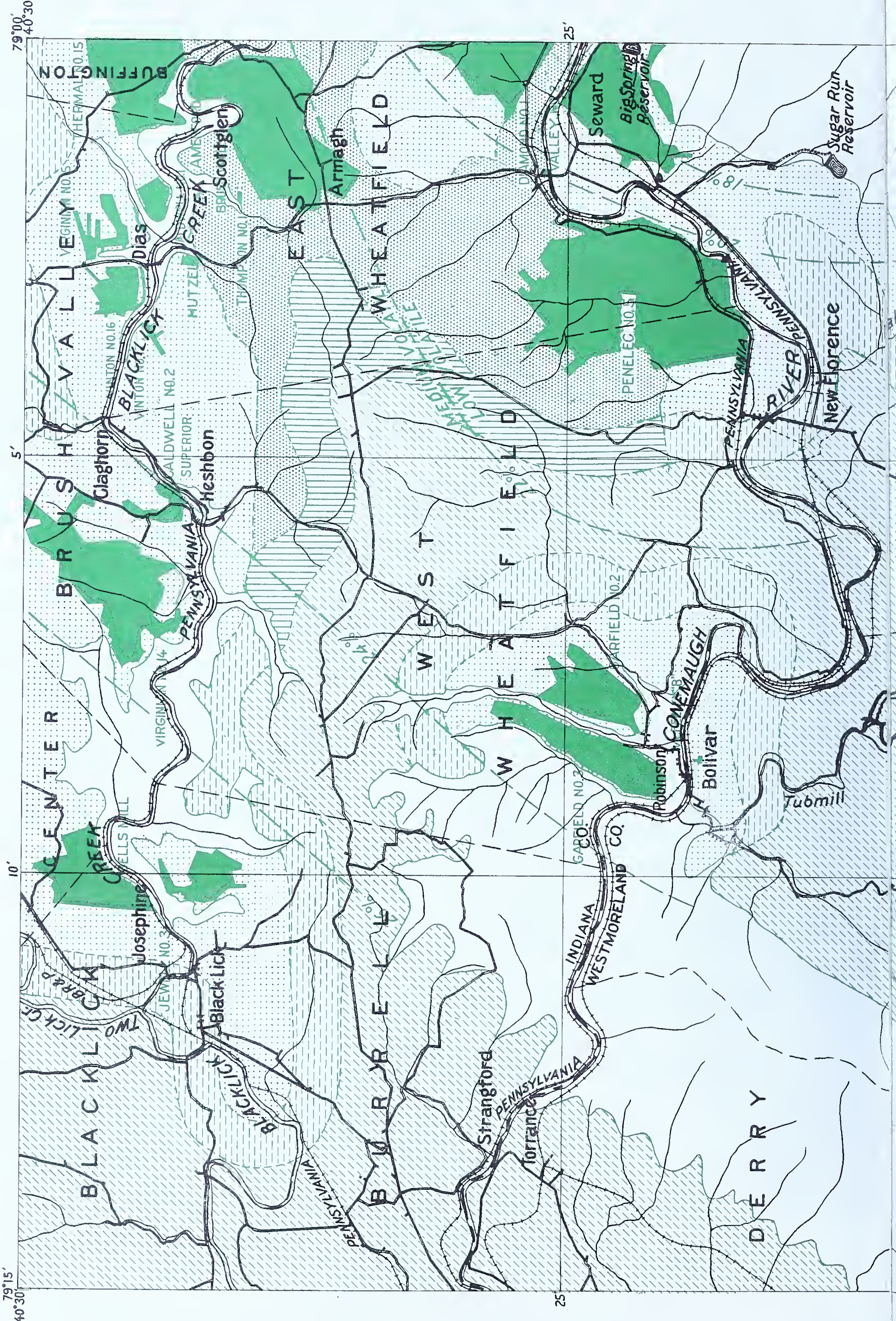


PLATE 7. CROSS SECTION ALONG INE



ON ALONG LINE A- A' SHOWN ON PLATE I.


79°00'
40°30'
25'
5'
10'
79°15'
40°30'
25'
BUFFINGTON
BRUSH VALLEY
CENTER
BLACKLICK
EAST WHEATFIELD
WEST WHEATFIELD
BURRELL
DERRY
INDIANA CO.
WESTMORELAND CO.
BLACKLICK CREEK
TWO LICK CR.
CONEMAUGH RIVER
PENNSYLVANIA
Dias
Scottglen
Armagh
Seward
Big Spring Reservoir
Sugar Run Reservoir
New Florence
Claghorn
Heshbon
Josephine
Black Lick
Strangford
Torrance
Robinson
Bolivar
Tubmill
THERMAL NO.15
VIRGINY NO.5
VINTON NO.16
VINTON NO.2
CALDWELL NO.2
SUPERIOR
HUTZEL
THOMPSON NO.1
DIAMOND NO.1
VALLEY
PENELEC NO.5
GARFIELD NO.2
VIRGINIA NO.4
WELLS MILL
JEWELL NO.3
MEDIUM VOLATILE
LOW VOLATILE
18%
20%
24%

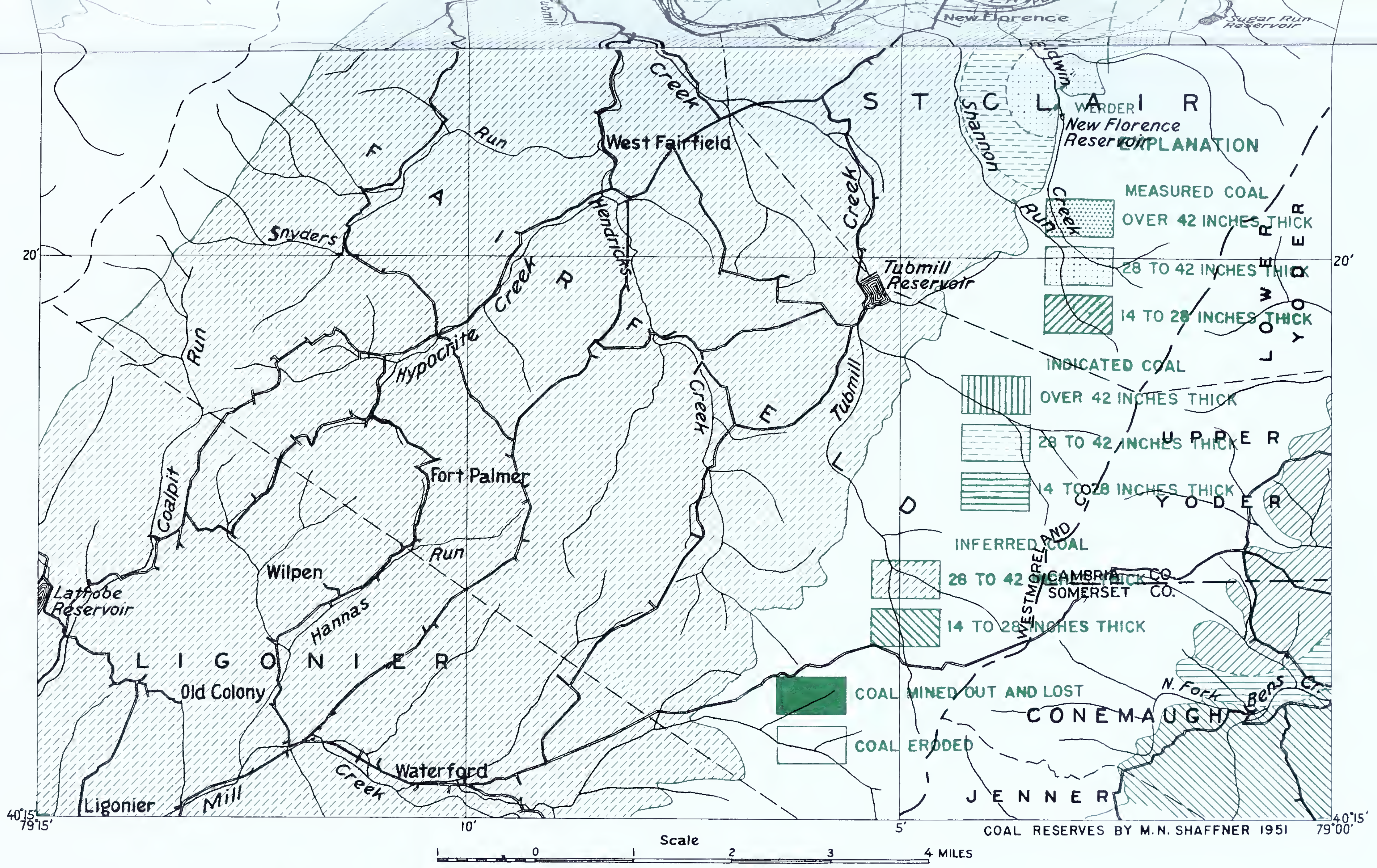
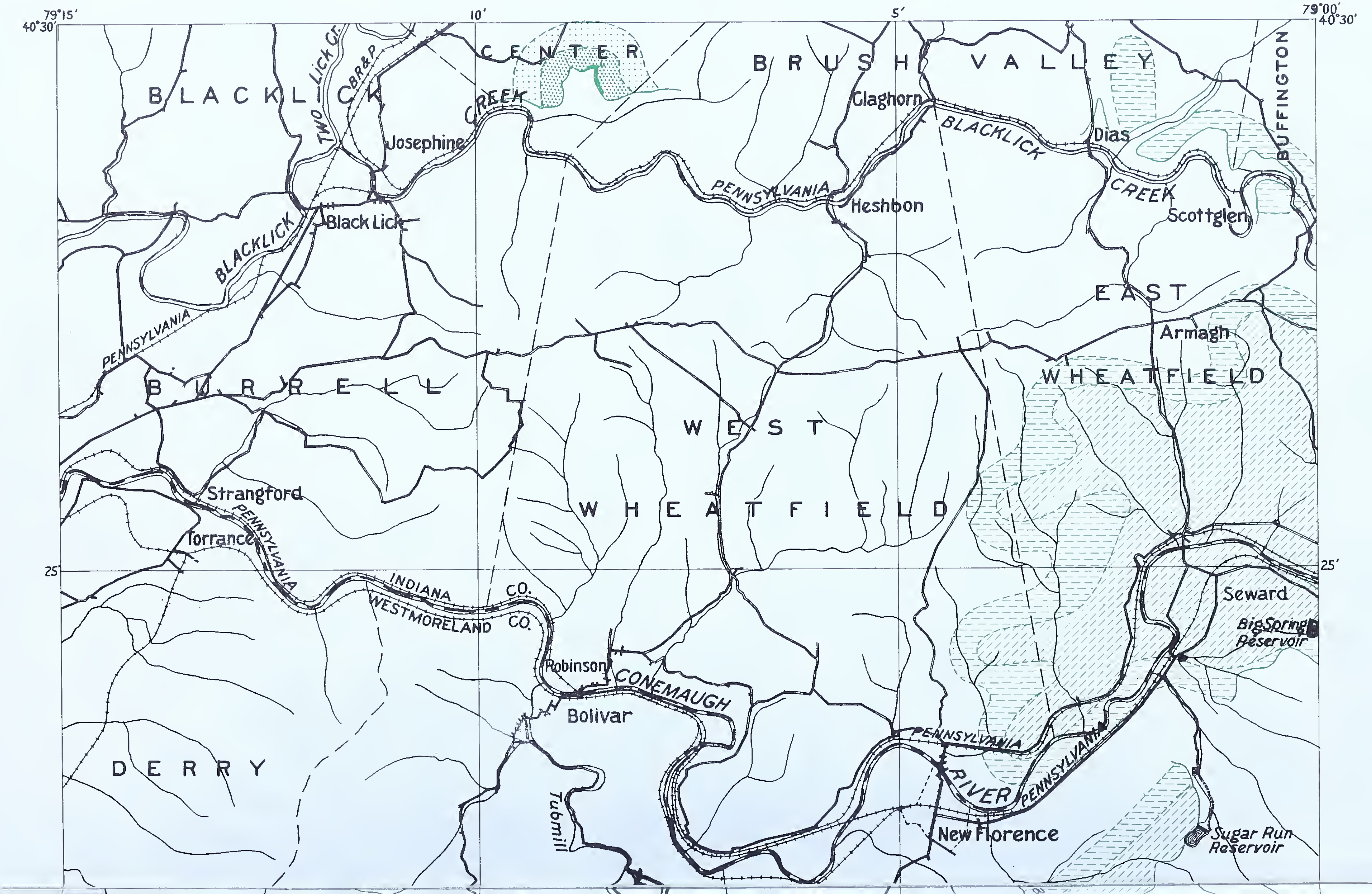


PLATE II. MAP SHOWING RESERVES OF LOWER KITTANNING COAL.


79°15′
40°30′
10′
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40°30′
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25′
BLACKLICK
CENTER
BRUSH VALLEY
BUFFINGTON
TWO LICK CR.
B.R.&P.
CREEK
Josephine
Claghorn
BLACKLICK
Dias
CREEK
Scottglen
PENNSYLVANIA
Heshbon
Black Lick
BLACKLICK
PENNSYLVANIA
EAST
Armagh
WHEATFIELD
BURRELL
WEST
WHEATFIELD
Strangford
PENNSYLVANIA
Torrance
INDIANA CO.
WESTMORELAND CO.
Seward
Big Spring Reservoir
Robinson
CONEMAUGH
Bolivar
PENNSYLVANIA
RIVER
PENNSYLVANIA
DERRY
Tubmill
New Florence
Sugar Run Reservoir

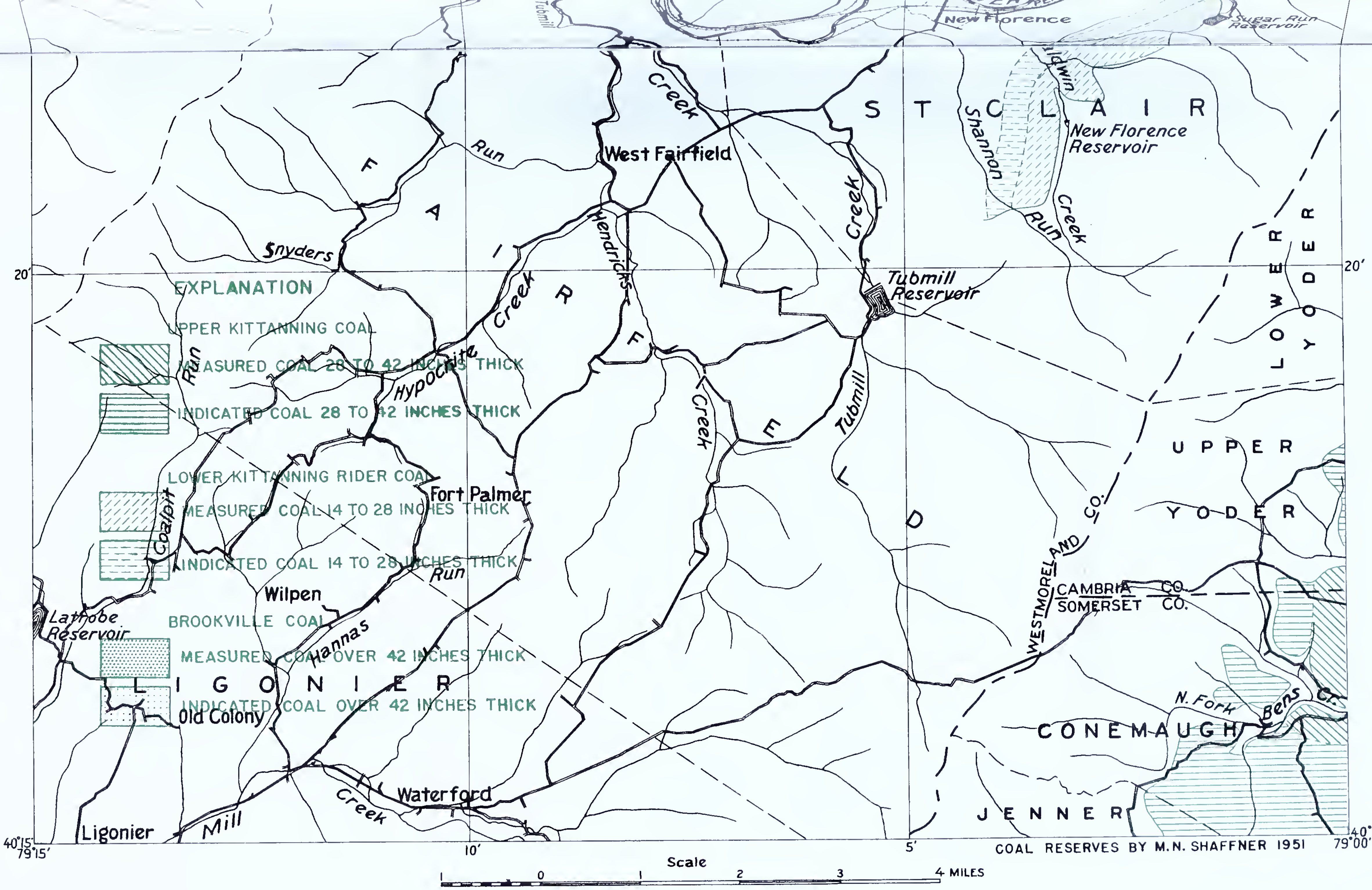


PLATE 12. MAP SHOWING RESERVES OF UPPER KITTANNING, LOWER KITTANNING RIDER AND BROOKVILLE COALS.

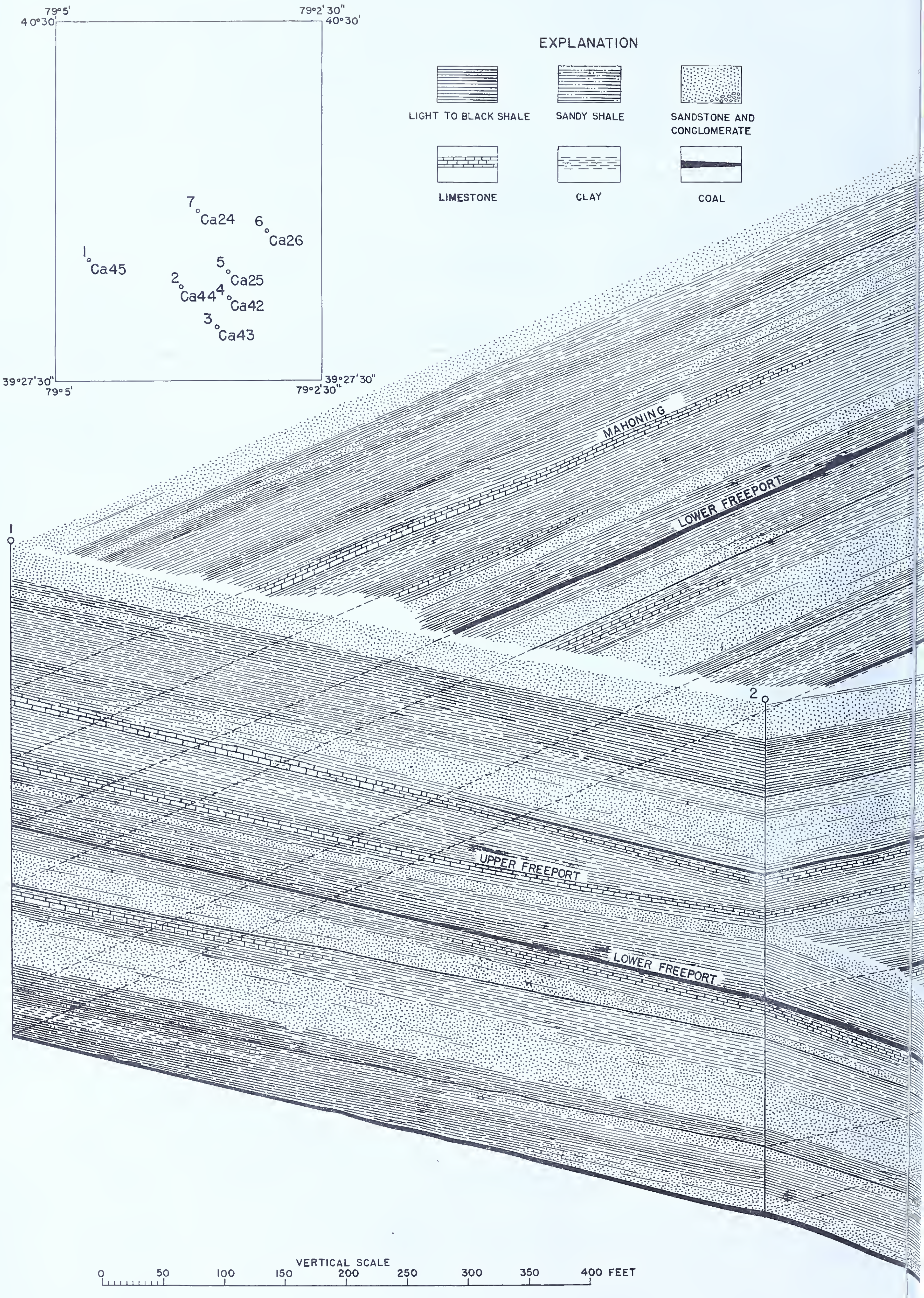
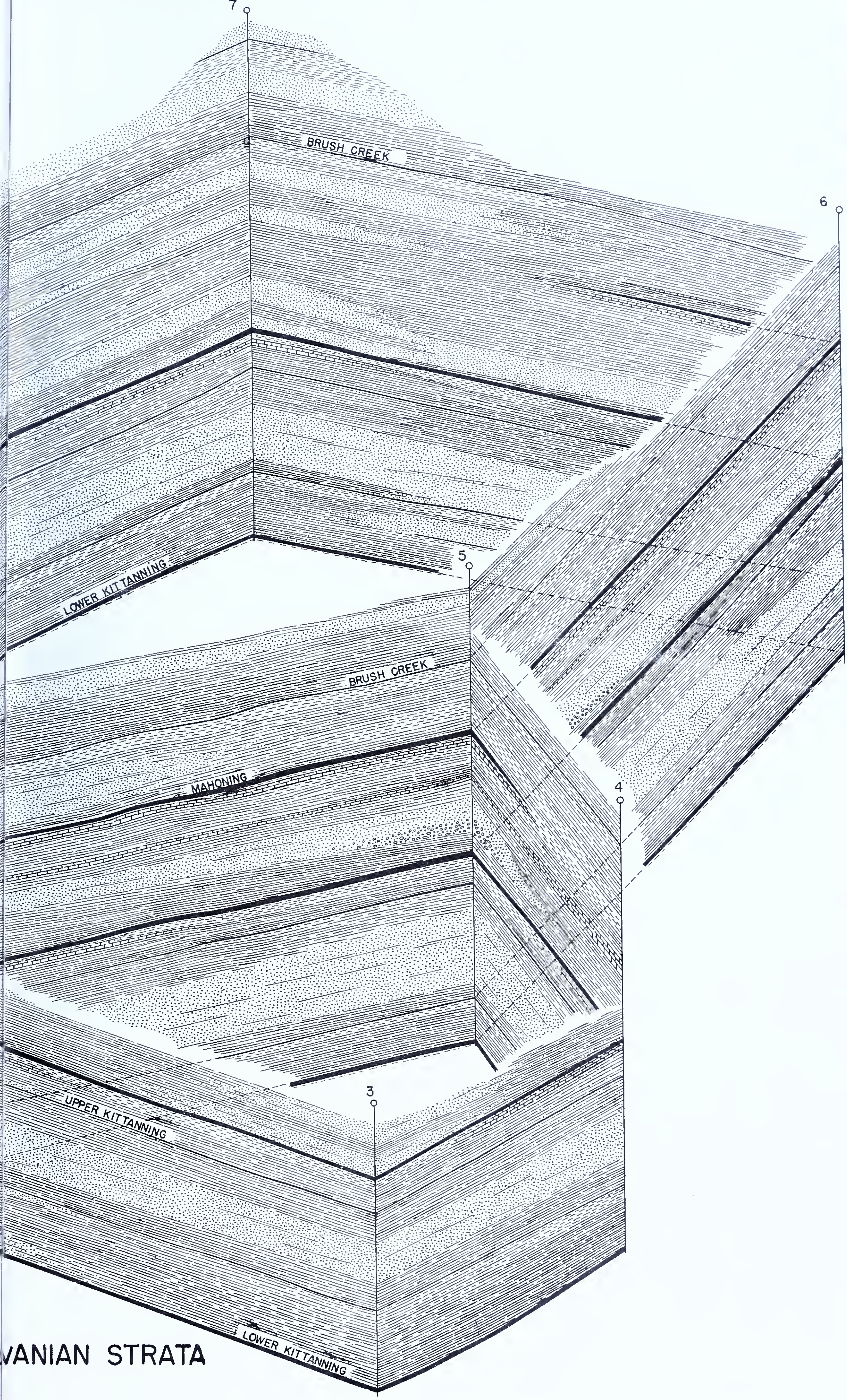


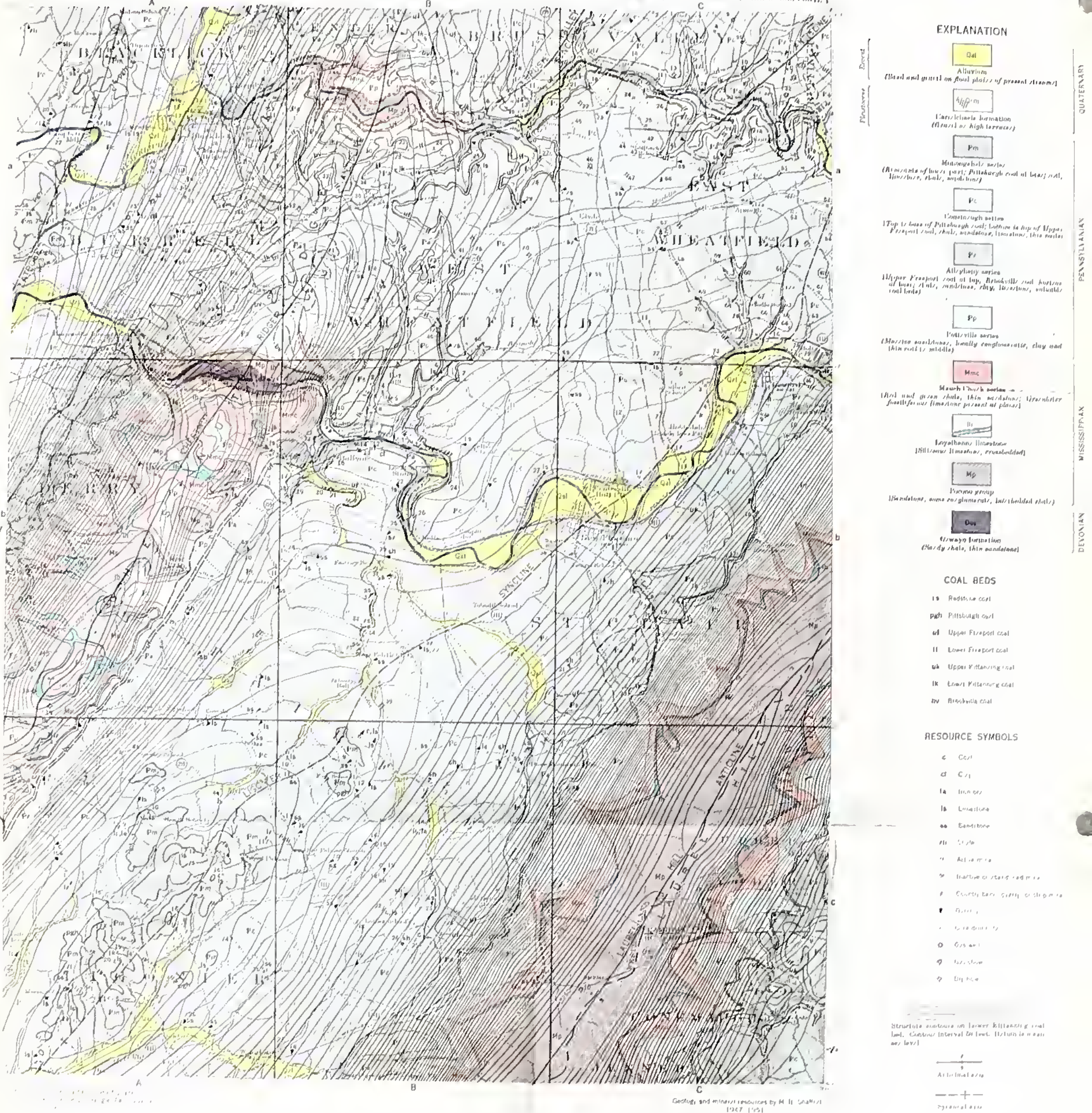
PLATE 6. FENCE DIAGRAM SHOWING VARIABILITY IN PENNSY



VANIAN STRATA

PENNSYLVANIA DEPARTMENT OF INTERNAL AFFAIRS
GENEVIEVE BLATT, SECRETARY
TOPOGRAPHIC AND GEOLOGIC SURVEY
CARLYLE GRAY, STATE GEOLOGIST

TOPOGRAPHIC AND GEOLOGIC
ATLAS OF PENNSYLVANIA
SHEET 57, NEW FLORENCE QUADRANGLE, PLATE 1



EXPLANATION

Recent	Qal Alluvium *(Sand and gravel on flood plains of present streams)*	QUATERNARY
Pleistocene	Qcm Carmichaels formation *(Gravel on high terraces)*	QUATERNARY
	Pm Monongahela series *(Alternating of lower part; Pittsburgh coal at base; coal, limestone, shale, sandstone)*	PENNSYLVANIAN
	Pc Conemaugh series *(Top is base of Pittsburgh coal; bottom is top of Upper Freeport coal; shale, sandstone, limestone, thin coals)*	PENNSYLVANIAN
	Pa Allegheny series *(Upper Freeport coal at top, Brookville coal horizon at base; shale, sandstone, clay, limestone, valuable coal beds)*	PENNSYLVANIAN
	Pp Pottsville series *(Massive sandstone, locally conglomeratic, clay and thin coal in middle)*	PENNSYLVANIAN
	Mmc Mauch Chunk series *(Red and green shale, thin sandstone; Greenbrier fossiliferous limestone present at places)*	MISSISSIPPIAN
	Ml Loyalhanna limestone *(Siliceous limestone, crossbedded)*	MISSISSIPPIAN
	Mp Pocono group *(Sandstone, some conglomerate, interbedded shale)*	MISSISSIPPIAN
	Do Oswayo formation *(Sandy shale, thin sandstone)*	DEVONIAN

COAL BEDS

rs	Redstone coal
pgh	Pittsburgh coal
uf	Upper Freeport coal
lf	Lower Freeport coal
uk	Upper Kittanning coal
lk	Lower Kittanning coal
bv	Brookville coal

RESOURCE SYMBOLS

c	Coal
cl	Clay
io	Iron ore
ls	Limestone
ss	Sandstone
sh	Shale
	Active mine
	Inactive or abandoned mine
	Country bank, quarry, or strip mine
	[illegible]
	[illegible]
O	Gas well
	Gas show
	Dry hole

Structure contours on Lower Kittanning coal bed. Contour interval 50 feet. Datum is mean sea level

Anticlinal axis

Synclinal axis

Geology and mineral resources by M. E. Shaffner
1947–1951

MAP OF THE NEW FLORENCE QUADRANGLE, PENNSYLVANIA

Showing Geology and Mineral Resources

Scale 1:24000

Contour interval 20 feet.
Datum is mean sea level

1957